Principles of Geriatric Physiotherapy

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Narinder Kaur Multani
BPT, MSPT, PhD
Professor and Head
Department of Physiotherapy and Sport Sciences
Punjabi University, Patiala
Punjab

Satish Kumar Verma
MSc (Physiology), PhD
Professor
Department of Physiotherapy and Sport Sciences
Dean Research, Dean Faculty of Medicine
Punjabi University, Patiala
Punjab

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Principles of Geriatric Physiotherapy

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Dedicated to
individuals in their
venture to conquer aging

Foreword

Life expectancy has been on an increase all over the world more so in the Indian subcontinent. Problems encountered with ageing are being understood today as the percentage population of this category is on the rise. The book has been authored by Dr. Narinder Kaur Multani and Dr. Satish Kumar Verma. Role of physiotherapy in managing the dysfunction due to the process of ageing are emerging. In this changing scenario it is heartening to see Dr. Narinder and Dr. Verma take on the task of bringing together the information in a readable format both for academicians as well as clinicians.

Dr. Narinder Kaur Multani has been a strongly motivated, goal-oriented person who has worked relentlessly to pursue both clinical and academic growth in Physiotherapy. She is one of the first therapists to understand and realize the need of physiotherapy in management of the various systematic problems faced by senior citizens. Dr. Satish Kumar Verma has a rich academic and illustrious research record to his credit. The coming together of two such committed individuals has helped the focus and direction of the book.

They have taken on the uphill task of authoring the book, compiling their research and learning for the benefit of the coming generation of physiotherapists. This is an area that will grow and develop into specialty of its own and this book is one of the first by an Indian author, addressing the role of Physiotherapy in geriatric population.

I hope this text will be read and followed in Physiotherapy, enabling students to understand better. The concepts would have taken time to conceptualize and document this information. It is an important body of work and one that will have a significant effect on how we treat our ageing population.

I hope that all who read this book will find themselves saying: “I have seen this scenario many times” with this knowledge, I can now treat these patients more effectively.

I congratulate Dr. Narinder and Dr. Verma for a comprehensive book and thank them for sharing their knowledge with all.

Prof. Savita Ravindra
Head – Department of Physiotherapy
M.S. Ramaiah Medical College and Teaching Hospitals
Bengaluru - 560054

Preface

The number of individuals aged 65 and older is continually growing at an unprecedented rate. The number of individuals older than 100 is also increasing day by day, even though the actual proportion of the elders among persons aged 65 and older is relatively small. The aged population in India is currently the second largest in the world. With the explosion in the number of elderly individuals, it is becoming increasingly important to emphasize the need to remain functional and have a good quality of life even at a very old age. Conventional wisdom tells us that creaky joints, lack of appetite and a closet full of medicines are an inevitable part of aging. But an increasing number of health professionals across the globe are endorsing the view that an appropriate exercise program can help the elderly sail through their golden years.

Many books providing current and accurate information on the problems of older people are available in the market. However, few books address the evaluation and treatment techniques that are used particularly by the physical therapists. Thus, *Principles of Geriatric Physiotherapy* presents a special set of information with regard to physiotherapeutic skills to evaluate and treat the older patients.

The text is organized into eleven chapters. The first chapter introduces the readers with the concept of geriatric physiotherapy. The second chapter presents the age-related changes in various physiological systems so that the reader can understand the pathophysiology of the common disorders of elderly individuals. The third chapter provides critical information on the response of the older person to exercise. The fourth chapter presents a comprehensive approach of evaluating the geriatric patients along with the assessment instruments. The fifth chapter presents physiotherapy strategies and techniques with necessary modifications for the geriatric patient. The sixth to eleventh chapters deals with the specific conditions and problems of elderly with special emphasis on physiotherapeutic interventions.

We hope that information provided in the book will make the students and clinical physiotherapists enable to employ the physiotherapeutic skills and knowledge for the betterment of older people or the people who, according to Dr Andrew Weil, the celebrated Professor of Medicine at the University of Arizona, should be respected for their

- Increased wisdom
- Increased life experience
- Maturity
- Depth of character
- Better equanimity
- Increased creativity

Narinder Kaur Multani
Satish Kumar Verma

Acknowledgements

First and foremost, we thank Almighty “VAHEGURU” who enabled us to write a book for the benefit of elderly: the fastest growing segment of our population.

We owe our sincere thanks to Sh. Tarsem Kumar Garg, Chairman, M.M. Education Trust, Mullana (Ambala) for his kind cooperation and motivation. We also express our gratitude to staff members of M.M. Institute of Physiotherapy and Rehabilitation, Mullana (Ambala) as well as Department of Physiotherapy, Punjabi University, Patiala (Punjab) for their time to time suggestions. We are especially grateful to Dr. Ashok kumar and Dr. Saurav Garg for helping us in preparing the illustrations. Thanks are also due to all elderly patients for participating in the Photographic sessions.

We express our profound sense of gratefulness to Dr. Savita Ravindra for being a pellucid and perennial fount of inspiration.

Finally we want to thank our parents and wonderful families for their support and encouragement. The endeavor could not have succeeded without their patience and co-operation.

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Geriatric Physiotherapy is a branch of health care system that deals with elderly care. It provides the knowledge regarding the health problems which are particularly experienced by a group of elderly. This knowledge can assist physical therapists in understanding the principles and perspectives that come into play when caring for the aged and even sometimes altering outcomes through preventive measures. It also provides the useful information regarding the prevalence of a particular condition and its incidence in elderly. Physical therapists can use this information to establish the goals of health care with older patients.

DEFINITION OF ELDERLY

By convention, elderly is defined as being 65 years of age or older.[1]

However, the onset of health problems of elderly may occur in early 50s or may be only in 40s. On the other hand, many times we come across the people who are healthy and active; even at the age of 70 years. It is because of these two contrasting representations of elderly in our society that this particular group of population should be defined in health terms:

"What defines this group is the frequent presence of multiple pathology and the atypical way in which illness can present with confusion, falls and loss of mobility and day-to-day functioning".[2]

As patients age, there is a transition in the health care, from primary prevention and curative interventions to secondary prevention and chronic disease management. To understand the complexity of the problems of aging patients and help them enjoy optimal quality of life, they are classified into smaller age ranges. In part this classification arose because the objectives of patient care change with advancing age.

CLASSIFICATION OF ELDERLY

Three groups have been identified:

Young-old: This group consists of the populations between 65 and 75 years of age. The young-old are somewhat similar to middle-aged patients. They have minimum level of disability. Hence the research studies pertaining to exercise physiology are mostly carried out in this particular group. With the average life expectancy of about 15 to 20 years, physical therapy is aimed at primary prevention of diseases. For example, by participating in a weight loss program, the obese patients can reduce their risk for cardiovascular disease. Similarly an appropriate combination of endurance and strengthening exercises can slow down the rate of decline in neuromuscular functions.

Middle-old: The populations between 75 and 85 years of age are included in this group. They exhibit the occurrence of chronic diseases. Physical therapist should exert the aggressive efforts to deal with the problems like osteoporosis, diabetic neuropathy, falls, etc. There is a decline in additional years of life expectancy. Physiotherapy is directed at the improvement of functional status in the finite remaining years.

Old-old: This group comprises of the populations older than 85 years of age. With the average additional life expectancy of 5 to 6 years, the old-old have the limited survival benefits from screening tests or therapeutic interventions. Taking this into account, physical therapist should concentrate on achieving human comfort. For example, passive movements, including trunk turning, positioning in bed or chair, warmth, attention and eye-to-eye contact have the great significance for the happiness of patients.

DEMOGRAPHY OF AGING

In the 20th century the elderly population has represented the fastest growing segment of total world population. However, these demographic changes were high-flying in developed countries. For example, in United Kingdom the population of people over 65 years has increased from 5 percent to 16 percent in this period. Figure 1.1 shows the increases in elderly population of America over the last hundred years.

Population projections suggest that this trend will be continuing in 21st century and elderly will represent 10.8 percent of total world population by 2025. Nevertheless these demographic changes will be more prominent in underdeveloped and rapidly developing countries than developed countries where these changes are slowing down. For example, in India over 82 million now, it will cross 177 million by 2025 and 324 million by 2050 which shows almost

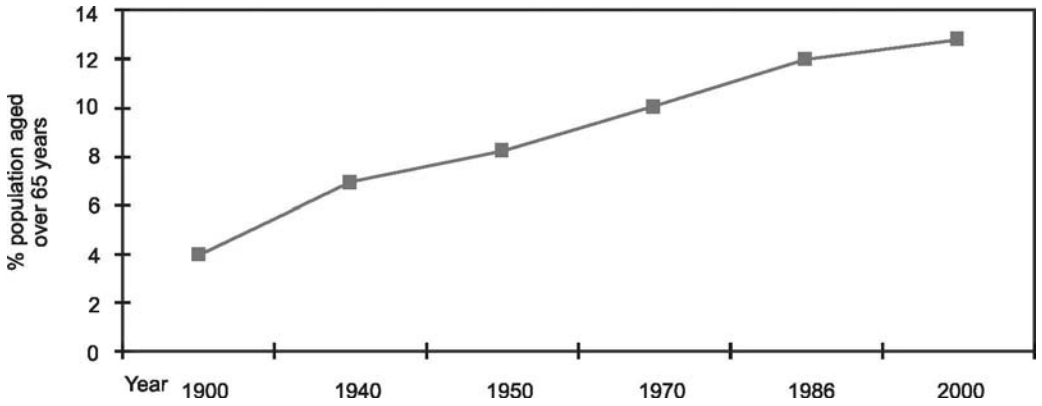

Fig. 1.1: The increases in % populations aged over 65 years in America over last 100 years

a two-fold increase in the proportion of elderly people. This is in contrast to America where currently 13 percent of elderly population will approach 22 percent by 2030 (Figs 1.2 and 1.3).

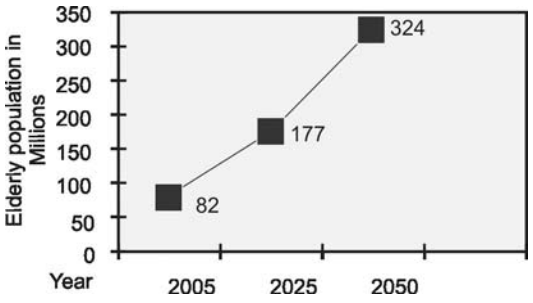

Fig. 1.2: Projected changes in the proportions of elderly population in India between 2005 and 2050

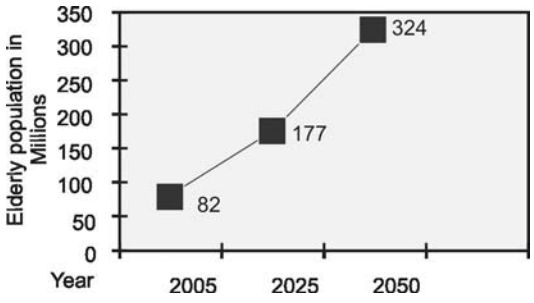

Fig. 1.3: Projected changes in the % of elderly population in America between 2004 and 2030

The startling fact is that the aged population in India is currently the second largest in the world. This was highlighted by Prof JJ Kattakayam, Director, Centre of Gerontological Studies, University of Kerala, Trivandrum, in his key-note address in the inaugural function of a two-day seminar on "Aging: issues and emerging trends, with special reference to women's problems" held at MCM DAV College for women, sector 36, Chandigarh, from 21-22 October, 2005.

FACTORS RESPONSIBLE FOR DEMOGRAPHIC CHANGES

Following *factors* contributed in the demographic changes occurred in the last century:

- Advances in medicine
- Healthier lifestyles
- Improved access to health care
- Dramatic reduction in perinatal and infant mortality
- A steady decline in the death rate from infectious diseases throughout adult life

- Generally better health before age 65
- Improved sanitation and nutrition
- Improved economy
- Involvement of people in their own health through diet, exercise and participation in health care
- Availability of information about health, disease and treatments through conventional media and the internet
- The strong societal focus on youthfulness
- Desire to be involved in health care
- The wish to promote health and avoid aging
- Interest in new ways to approach problems

IMPLICATIONS OF DEMOGRAPHIC CHANGES

The changing scenario of the demography of elderly has a major impact on the health and social services. Life expectancy today is 74 years for men and 80 years for women, a remarkable rise in longevity from 100 years ago, when men lived an average of 48 years and women an average of 51 years[1]. While gains in average life expectancy is the indicator of nation's well being, it does not imply that these additional years of life are the quality years. Rather, it has been postulated that there is an exponential increase in disability, and mental and physical morbidity, in individuals over the age of 75 years. In the UK, the estimated prevalence of those with severe disability is less than 1percent in those aged 50-59, but 13 percent in those aged over 80 years.[2] Olshansky and others have also argued that there will be an expansion of morbidity as medical technology improves the likelihood of survival from previously fatal diseases without improving overall quality of life for these individuals.[3] Hence it is imperative to evaluate the status of elderly in detail so as to understand the role of Geriatric Physiotherapy in modifying and upgrading the quality of life in old age.

SEX DISTRIBUTION AND MARITAL STATUS OF ELDERLY

There are 77 million older persons in India according to 2001 census, of which 37 million are males and 40 million are females. This shows significant probability of older women for living longer than their spouses. There is also a significant chance of women living alone. This is largely because of widowhood, creating a lot many problems for them. At present, 19 million elderly women are widows, 80 percent of them live in villages, a majority in the unorganized sector with no pension plans, provident fund, gratuity or medical cover as security in trying times.

SOCIOECONOMIC STATUS OF ELDERLY

Financial and emotional support is of utmost importance for elderly as poverty and dependency increases with age. Loss of spouse and distance of family often results into loneliness. In India, 12 percent of elderly population is living alone in villages and 10 percent in cities. The reasons as to why poverty increases with age may be that the cost of medications, professional services and personal help increases with age, whereas incomes do not. 40 percent of Indian elderly population is living below the poverty line.

DISEASE, DISABILITY AND DEATH

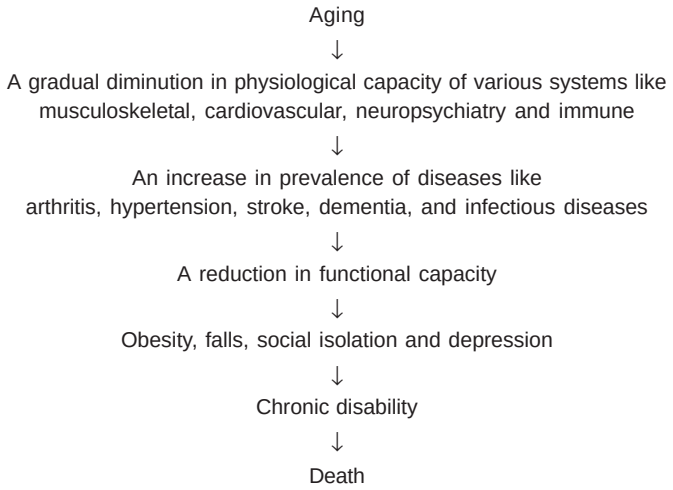

Fig. 1.4: Schematic presentation of relationships between disease, disability and death

Interdependent relationships between disease, disability and death in elderly are well known (Fig. 1.4). As individual ages, there is a gradual but definite reduction in physiological capacity of various systems like musculoskeletal, cardiovascular, neuropsychiatry and immune. This makes the elderly predisposed to certain diseases like arthritis, hypertension, stroke, dementia and infections. As an outcome, there is a decrease in functional capacity of elderly causing social isolation, depression, chronic disability and ultimately death. The three most common causes of death in elderly are coronary heart disease, cancer and stroke.[4] Over last three decades, the mortality rate from CHD has come down; still it remains the leading cause of death in elderly population throughout the world. In 1988, arthritis was the most prevalent self-reported condition of elderly, followed by high blood pressure, hearing impairments and heart disease. These conditions are even more prevalent among elders who are alone and poor.[9]

The linear relationship between disability and age has also been reported by Established Populations for Epidemiologic Studies of the Elderly (EPESE) on the basis of preliminary data from the National Institute on Aging.[5] The EPESE data indicated that physical disability is most prevalent in the oldest-old. It was further observed that physical disability is more prevalent for elderly women than men at every age. When it comes to the cause of disability in elderly, several studies point toward the cardiovascular diseases such as angina pectoris and hypertension.[6-8] The other causes of disability include diabetes, arthritis and being overweight.

TO SUMMARIZE

With the outburst in the number of elderly in our society, it has become a challenging job for the physiotherapists to promote health and prevent disability in individuals over 65 years of age. Unfortunately, at present the physiotherapists specialized in geriatric physiotherapy are few in number. Hence, it is need of the hour to enhance the existing knowledge and skills for the management of continually growing patient's physiotherapeutic needs while maintaining high quality care and services.

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2 Physiological Response to Aging

- **Normal Aging**
- **Mechanism of Aging**
  - Theories of aging based on intrinsic factors
  - Theories of aging based on extrinsic factors
- **Features of Normal Aging**
- **Musculoskeletal System**
  - Muscular strength
  - Muscle mass
  - Muscular endurance
  - Muscular power
  - Bone health
  - Articular cartilage
- **Cardiovascular System**
  - Aerobic capacity
  - Heart
  - Heart rate
  - Cardiac output
  - Local factors
- **Pulmonary Function**
- **Nervous System**
  - Central nervous system
  - Peripheral nervous system
- **Special Senses**
  - Visual acuity
  - Hearing
  - Taste
  - Smell
  - Touch
- **Vestibular System**
- **Changes in Other Systems**

NORMAL AGING

It is an artificial concept which describes physiologic changes that occur with advancing age. Normally physiological capacity of various systems attains a maximum level in 3rd decade of life-between the late teens and thirty years of age. After 35 years there occurs a decline in physiologic and performance measures. Nevertheless, the rate of decline varies from individual to individual and from one physiologic system to another. For example, nerve conduction velocity declines only 10 to 15 percent from 30 to 80 years of age, whereas resting cardiac index declines 20 to 30 percent; maximum breathing capacity at age 80 is about 40 percent that of a 30-year-old.[1] The rate of decline in function also varies from individual to individual. For example, an individual may be active and independent at the age of 80 years, whereas a 65 year old may have many problems. This means that chronological age does not necessarily correlate with biological age. Thus, the physiology of aging seems to be extremely complex and diverse.

WHY AGING

Many researchers have tried to find out the cause of aging. Two kinds of theories have been postulated to explain why aging occurs.

Theories of Aging Based on Intrinsic Factors

Theories in this category indicate that aging is intrinsic to the organism and is genetically controlled and programmed.[2] A genetic theory proposed by Finch and Landfield reported that changes in the endocrine system are central to aging.[3] According to this theory degenerations in these systems may result in degeneration in many other bodily systems. Another theory is based on genetic replication.[4] It suggests that less exact cell replication increases the likelihood of mutations, reduced function and possibly death. The free radical theory postulates that the accumulation of free radicals, which are very reactive, can cause random damage within the cell.[5] Yet another idea indicates that individual cells contain mechanisms that produce aging. This is supported by the study conducted by Hayflick and Moorhead in 1961.[6] They reported that cells grown in culture without environmental insults, hormonal influences, or immune system changes; grow old and die.

Theories of Aging Based on Extrinsic Factors

Theories in this category point out that aging results from either environmental insults or mistakes. One of these theories suggests that background radiations may produce cellular mutations that accumulate and may lead to function failure and death.[7] The negative, cumulative consequences of radiographic exposure support this theory. Another example is a photochemical event that is the end product of the UVR-induced chemical excitation due to over-exposure to sunlight. This results in an alteration of cell biochemistry and cellular metabolism. The synthesis of DNA and RNA is affected, leading to alterations in protein and enzyme production. As a consequence, cell protein structure can be altered, and this alteration of cellular protein and DNA may leave the cell inactive or dead.[8, 9] The occurrence of osteoarthritis due to disproportion between stress

and stability of a joint is another evidence that supports the idea of theories of aging based on extrinsic factors.

Thus, it seems rather than a single mechanism, there is more than one factor responsible for aging, possibly a combination of intrinsic and extrinsic factors. What is more important is to accept the inevitability of aging, as rightly said by Dr. Andrew Weil, the chief guru of integrative medicine in the United States: "we cannot turn back the clock".

Features of Normal Aging

A Physical therapist has a key role to play in the geriatric rehabilitation team. A sound knowledge of features of normal aging provides a baseline against which a thorough evaluation of elderly patients can be carried out. The features of normal aging, however, differ from one physiologic system to another; hence they should be discussed system wise.

MUSCULOSKELETAL SYSTEM

Age-related changes in musculoskeletal system are very important, as they are directly related to limited mobility as well as increases in the incidence of falls in elderly.

Muscular Strength

Men and women usually achieve maximum muscular strength between the ages of 20 and 30 years.[10, 11] Thereafter there is a progressive decline in muscular strength in a variety of muscle groups and during different types of muscular contractions.[12, 13] Insufficient muscular strength can contribute to major functional losses of even the most basic activities of daily living. There may be at least 16.5 percent reduction in muscle strength after the third decade of life.[14] The deterioration in muscular strength further accelerates with aging. The overall age-related strength loss ranges from 24 to 45 percent.[15]

Muscle Mass

Reduced muscle strength is associated with reduced muscle mass. The muscular cross-sectional area is at its largest between the ages of 20 and 30 years.[1] There is significant reduction in the cross-sectional area of the muscles in the upper and lower extremity for both men and women, as they age.[16-18] The reduced muscle mass may result into reduced activity and disuse atrophy which further aggravates the reduction in muscle mass as well as muscle strength. The changes in muscle composition reflect a loss of total muscle protein brought about by inactivity, aging or both.[19] The loss of muscle volume in older people may be due to a reduction in either the size or the gross number of muscle fibers or both.[20, 21] The researchers have also tried to know the type of muscle fibers that undergoes the atrophy. Some studies indicate that it occurs particularly in the type II (fast-twitch) fibers[22, 23] whereas other studies suggest that all muscle fibers are affected.[24]

There are several electromyographic studies which demonstrate a loss of functioning motor neurons in the elderly.[25] How does it relate with loss of muscle mass is explained in Fig. 2.1.

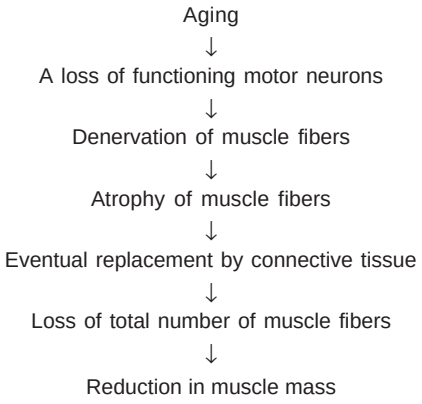

Fig. 2.1: Possible mechanism of reduction in muscle mass

Muscular Endurance

Muscular endurance is the ability of a muscle to contract repeatedly against a load, generate and sustain tension; and resist fatigue over an extended period of time.[26-28] It is the common observation that as the individual ages, an ability to carry out daily tasks with vigor and alertness, without undue fatigue is decreased. Susceptibility to fatigue can be indicative of a declination in muscular endurance in older persons. Most of the research studies focus on muscle strength rather than endurance. Hence, more and more studies should be carried out to understand the relationships between fatigue and muscle endurance in elderly.

Muscular Power

Muscle power reflects the ability of the muscle to perform work in a given time interval. The average muscle power is simply the mechanical work divided by the time required to perform that work. Peak power is the maximal power produced during a movement. This value is easily obtained using an isokinetic device by multiplying the moment of force by the angular velocity. Thus, power depends on both the force produced and the speed of movement.

Little work has been done on muscular power of older persons. A comparative study conducted in 1986 reported that the 60-years-olds exhibited significantly less maximum power and total work in comparison to 20-years-olds during a 30-second maximal cycling test on an isokinetic ergometer.[29] An inability to produce powerful muscle activation is the inability to meet unforeseen emergencies and therefore decreased muscular power may be a key risk factor in fall injuries in elderly. It is hoped that further research will provide better insight into this parameter of muscle performance.

Bone Health

During growth, bone modeling improves bone strength by adding bone mass, increasing the length and diameter of long bones like the radius and femur; and by fashioning the trabecular network to meet the loads in bone sites such as the vertebral bodies and the femoral neck. Remodeling maintains bone mass and mechanical competence in the adult skeleton by replacing the damaged and degraded bone tissue with new tissue. With ageing, however, the remodeling

tends to remain uncoupled in that packets of bone removed during resorption are not completely replaced during bone formation, resulting in a net loss of bone.[30, 31]

The decline in bone mass and structural integrity becomes evident around 50 years of age, particularly in women during menopause, whereupon bone resorption is increased due to estrogen deficiency. In long bones, aging and osteoporosis are manifested as endocortical bone loss, which is greater in women than in men when related to bone mass. There is also less periosteal enlargement in women during both growth and aging, resulting in lower section modulus and further weakness in the female bone.[32,33] Excessive age-related widening of the endocortical cavity predisposes bone to structural failure by local buckling.[34] Bone loss in early menopause is associated with increased fracture risk of the vertebrae and the distal radius in women, while osteoporosis in older age is manifested by hip and vertebral fractures in both men and women.[35] The relationship of bone mass to muscle mass[36] and fracture risk[37] is, as such, similar in older men and women, but due to the greater number of older women and their lower bone and muscle mass and strength, osteoporosis appears as a major female health problem.

Articular Cartilage

Structural changes related to age occur mostly in the superficial layer of articular cartilage. Scanning electron microscopy has disclosed an uncovering of superficial collagen bundles that seem less coated with matrix and is torn off in places, with fibrils floating in the joint cavity.[38] A decrease in the cell density of the superficial layers of hip[39] and knee[40] cartilages with increase in age has also been described.

Some age related changes in the mechanical properties of articular cartilage have been documented.[40] The compression stress–strain curve and the tensile stiffness under weak force (5 MN/m^2) do not vary with age,[41, 42] but under strong stresses (10 MN/m^2) the tensile stiffness decreases in an age related way.[42] Increased compliance with age would allow increased contact area of articular surfaces under load.[43] The fibrous network of articular cartilage appears to become increasingly prone to fatigue failure with advancing age, i.e., the number of repeated stresses necessary to rupture piece of cartilage stretched parallel to its superficial fibres decreases significantly with the advancing age of the individual from whom the specimen was obtained.[44, 45] The mechanism of the change is not known. It has been postulated that the alteration could result from a slow change in the perifibrillar coating material, a progressive disruption of intermolecular cross-links between collagen, monomers, or changes in fibrillar hydration. In this respect, the description of "minor" collagens type IX and type XI copolymerized with collagen type II in the collagen fibres[46] is of interest and importance.

Age-related biochemical changes include a small but significant decrease in the water content of articular cartilage, from approximately 75 percent to 70 percent, especially in the deeper layers.[48] Hyaluronic acid concentration has been reported to rise from 1 percent to 6 percent between the time of skeletal maturity and age 60.[43] Some age-related changes in collagen and proteoglycan composition have also been reported in the literature. For instance, cartilage collagen from older subjects becomes even less soluble in salt and acid solutions than from young adults[46,49] whereas the mean length of proteoglycan monomers decreases at the expense of the chondroitin-rich region, thus decreasing the chondroitin sulfate/ keratan sulfate ratio.[50,51] Changes in the staining properties of the superficial layer of articular cartilage with advancing age have

suggested that in specimens from older individuals, keratan sulfate, usually found mostly in the deep layers, is found near the surface.[47]

CARDIOVASCULAR SYSTEM

Aerobic Capacity

Aerobic capacity is a measure of body's capacity to use oxygen, hence, depends on the transport of oxygen, the oxygen-binding capacity of blood, cardiac function, oxygen extraction capabilities and muscular oxidative potential. Usually it is expressed relative to body weight, as ml/kg per minute and mathematically; it is defined as the Fick equation

$$VO_2 = CO \times (a\text{-}v)\ O_2$$

Where VO_2 = oxygen consumption

CO = cardiac output

(a-v) O_2 = arteriovenous oxygen difference or peripheral extraction of oxygen

The oxygen consumption during rest as well as submaximal exercise does not change with age.[75-77] On the other hand, the maximum ability of the body to use oxygen during exercise (maximum oxygen consumption) declines with age.[76-78] It has been estimated from cross-sectional data that the decline in max VO_2 is approximately 0.4 ml/kg per minute each year.[79] The factors which influence the decline in max VO_2 are the various age-related decrements in central as well as peripheral physiologic functions linked to oxygen transport and utilisation.[80]

Heart

Heart tissues may deteriorate and cardiac (heart) muscles decrease in size, leaving room for fat and calcium deposits. Ventricular weight may be increased due to the accumulation of fat, fibrous tissue, lipofuschin and amyloid. Blood volume becomes less. This is partly because of impaired ventricular diastolic relaxation and compliance which in turn results into impaired diastolic filling of the heart. The heart works harder but accomplishes less. With age, number of pacing myocytes reduces in sinoatrial node, causing an increased risk of atrial fibrillation.

Heart Rate

Heartbeats become fewer and more irregular. On an average, the resting heart rate does not change as much, with age. The most apparent age-related change is a decline in maximum heart rate. The maximum heart rate declines to the same extent in both males and females. Roughly, it is estimated according to following formula:

$$\text{Max HR} = 220 - \text{age (years)}$$

The decrease in maximum heart rate starts by the age of 40 years and proceeds linearly as the individual ages. This may be due to decreased responsiveness of both beta –1 and beta –2 adrenergic receptors.

Cardiac Output

The aging heart is often incapable of increasing cardiac output during maximum exercise. In addition to above mentioned changes in heart and a decline in maximum heart rate, the contributing

factor is an increased after-load. After-load is increased due to the increase in systemic vascular resistance with age. This increased after-load results into a decrease in left ventricular ejection. Thus, maximum cardiac output reduces with age.

Local Factors

With age, aorta and blood vessels harden and shrink. This reduces the arterial cross-sectional area. Other age-related changes are reduced muscle mass, a decrease in the capillary-to-muscle fiber ratio and loss of tissue compliance. The net result of all these changes is a reduction in peripheral blood flow capacity with aging.

PULMONARY FUNCTION

Effectiveness of the lungs diminishes faster than the heart. A 75-year-old's lungs are only 56% as efficient, the minimum breathing capacity is 43% and the maximum oxygen intake during exercise is only 40% that of a 30-year-old. Several studies indicate that both static and dynamic measures of lung function generally deteriorate with age.[81,82] Reduced vital capacity, reduced peak expiratory flow, increased residual volume, decreased inspiratory reserve volume and reduced arterial oxygen saturation are some of the examples. This may be as a consequence of a loss of elastic recoil in the lung, reduced alveolar support, increased rigidity of the rib cage, decreased strength of the respiratory muscles and reduced pulmonary gas exchange function with age.[83] Loss of efficiency in breathing is particularly evident during exercise. For example, many times the elderly complaint of shortness of breath while going upstairs. The work of breathing increases as there is increase in the intensity of exercise. More intense exercise produces a higher blood lactate concentration and greater blood acidosis. The body responds by increasing ventilation to expire more carbon dioxide and reduce the acidosis.[84] Thus, the older people have more ventilation for the same oxygen than the younger people.[85]

NERVOUS SYSTEM

In 37 BC, the Roman poet Virgil stated: "Age carries all things, even the mind away".[56] Thus, age-related decline is expected even in the nervous system. These cumulative effects of aging are exhibited in central as well as peripheral nervous system.

Central Nervous System

The brain of an elderly shows several significant anatomical, physiological and neurochemical changes. There is a decrease in the weight of brain with advancing age. For example, the mean weight of brain of women in the age group of 21 to 40 years is 1260 gm, whereas for women over the age of 80 years it is 1061 gm.[57] Gyral atrophy and ventricular dilatation are other age-related changes in brain.[58, 59] All of these anatomical changes indicate neuronal loss with age. It has been documented that by the ninth decade of life, 30 to 50 percent of cortical neurons are lost in certain areas.[60] No age-related cell loss has been reported in certain portions of the basal ganglia, hypothalamus or a variety of brain stem nuclei.[61] Brody and Vijayashankar have also noted that although the brain loses thousands of cells daily, the areas of brain involved in language, memory and cognition are relatively spared of significant loss of neurons.[67] The most

important physiological change that occurs with age is the diminution in cerebral blood flow and cerebral metabolic rate of oxygen utilisation.[62] This, in turn, may be responsible for neuronal death. Many studies have reported about the neurochemical changes in central nervous system. For example, White et al, have suggested that there is a decline in synthesis as well as spontaneous release of acetylcholine with age.[63]

Peripheral Nervous System

An age-related decline in some of the peripheral receptors as well as afferent nerve fibers has been demonstrated in many studies. With age, there is a decrease in the number of Meissner's corpuscles that are responsible for the detection of touch stimuli in the area of hairless skin.[64] However, Merkel cells, which are also touch receptors, do not show similar changes.[66] Pacinian corpuscles, which sense the vibratory stimuli, decrease in density with advancing age. Corbin and Gardner have noted a 32 percent loss of fibers in both the dorsal and ventral roots of T8 and T9 in the 9th decade.[65] Peripheral nerves also show similar kind of age-related changes. Physiological alterations occurring in peripheral nervous system with age are a 10 percent decline in nerve conduction velocity and a significant loss in elastic properties of connective tissue.[1]

In experimental settings the age-related changes in brain are manifested by a decrease in the ability to register, retain and recall certain recent experiences, a slower rate of learning new material, slower motor performance on tasks that require speed, and difficulties with fine motor coordination and balance.[68, 69]

A slowing of the natural pace of movement is a common feature of aging which is exhibited in brain by a slowing of resting electroencephalogram (EEG) rhythms. The average change in EEG frequency is about one cycle per second per decade between 60 to 80 years.[70]

Another common manifestation of age-related changes in nervous system is an increase in reaction time, i.e., the time required to initiate a movement following stimulus presentation. When this reaction time is divided into central processing time and muscle contraction time, it is the central processing time which is most influenced by the aging process. Both simple and complex reaction times are affected with age.[71,72] However, the reflexes, for example, knee jerks are less affected with the age than the voluntary responses such as reaction and movement times.[73] This is probably because the reflexes do not involve the central processing.

The Arndt-Schultz Principle summarizes the changes between the younger and the aged brain's ability to respond to stimuli: [74]

1. The elderly require a higher level and/or a longer period of stimulation before the threshold for initial physiological response is reached.
2. The physiological response in the aged is rarely as big, as visible, or as consistent as is noted in the younger age groups.
3. The only similarity between the response of the young and the elderly to stimuli is that once the threshold is reached, the more stimuli that are provided, the greater the response.
4. On average, the range of safe therapeutic stimulation is narrower for the elderly than for the young.

SPECIAL SENSES

Visual Acuity

Visual acuity is a measure of visual discrimination of fine details.[52] There is a gradual decline in visual acuity after the 5th decade of life. This decline in visual acuity results into visual impairment interfering with the functional independence and causing social isolation and depression in the elderly. Visual impairment is defined as visual acuity of less than 6/18 and greater than 6/60. Blindness carries a range of definitions from no vision at all to "visual acuity of less than 3/60 in the better eye with the best possible correction". Later is the definition given by The World Health Organisation. In India, blindness is defined as "visual acuity of less than 6/60 in the better eye with the available correction".

In general, age-related eye changes can be either functional or structural. Functional changes include Presbyopia, decreased refractive power, decreased dark adaptation, decreased contrast sensitivity, visual field constriction, decreased tear production that results in dry eyes; and increased difficulty with upward gaze and convergence. Presbyopia meaning the progressive loss of lens accommodation for near vision, usually becomes apparent in the 4th decade of life. Structural changes are lens enlargement, resulting in narrowing of the anterior chamber angle; decreased lens translucency resulting in decreased retinal illumination; increased lens stiffness and decreased curvature; rod cell loss; liquefaction of vitreous gel; loss of eyelid tone, resulting in entropion or ectropion; and rising in intraocular pressure.

Age-related macular degeneration, cataract, diabetic retinopathy and glaucoma are the common age-related ocular diseases. In developed countries, 60 percent cases of blindness are from age-related macular degeneration whereas in developing countries; cataract, diabetic retinopathy and glaucoma are the important causes of visual impairment and blindness.

Hearing

The incidence of hearing loss is estimated to double per decade, beginning with 16 percent at 60 years of age and proceeding to 32 percent at 70 years and 64 percent at 80 years. When matched for age, males tend to have worse hearing than females.[53] Age-related changes in auditory system affect the peripheral as well as central pathways. Tables 2.1 and 2.2 describes the common hearing changes and their consequences respectively.

Changes in the peripheral sensory organ, the outer, middle or inner ear: The outer ear shows degeneration of elastic fibers, decrease in collagen, thinning of surface epithelium and atrophy of subcutaneous tissue causing reduction in elasticity and strength. Sebaceous and cerumen glands loose their secretary activity. Length and thickness of hair follicle increase. As a consequence, skin becomes dry, prone to trauma and ultimately breaks down. Also, cerumen becomes hard and impacted in older individuals, resulting into conductive hearing loss.

Age-related changes in middle ear do not cause a major effect on hearing. However, the inner ear exhibits vivid changes with detrimental effects on pure tone threshold and speech understanding. These changes in inner ear are also responsible for presbycusis, the most common pattern of hearing loss in elderly people.

Changes in the central pathway and the auditory portions of the cerebral cortex: Hearing loss is also compounded by complex central auditory disability. With age there occurs degeneration of both outer and inner hair cells of basal region of cochlea, causing a typical hearing loss in older

people, best known as presbycusis. Similarly, spiral ganglion cells undergo degeneration and causes changes like elevated pure tone threshold and poor discrimination score. Age-related changes are also observed in central auditory system from cochlear nucleus up to auditory cortex such as decrease in no. and size of cell body nucleus.

Table 2.1: Common hearing changes

➢ Presbycusis – a bilateral high frequency sensorineural hearing loss
➢ Elevated pure tone threshold
➢ Diminution in speech discrimination
➢ Deterioration in word recognition and sentence identification tasks

Table 2.2: Consequences of hearing loss

Hearing loss may lead to feelings of
➢ Isolationn
➢ Anger
➢ Fearfulness
➢ Anxiety
➢ Embarrassment
➢ Low self-esteem
➢ Depression

Taste

With age, the sense of taste diminishes mainly due to decrease in the number of taste buds on circumvallate papillae. There is a loss of approximately half of the taste buds by the age of 60. The reduction in gustatory function may be attributed to other age-related changes such as neuron reduction in taste centers, reduced elasticity of mouth and lips, epithelial atrophy of lingual mucosa, increased fibrosis of submucosal connective tissue; and decreased average output of saliva.

Since the threshold for salty and bitter taste is increased in older individuals, they may use excessive amounts of salt or prefer sweets. This can create problems for hypertensive and diabetic elderly.

Smell

Sensation of smell declines, as the individual ages. Nevertheless, the degree and rate of decline is specific to the type of odor and varies from individual to individual. The age related decline in the threshold of olfactory function may be due to fiber loss in olfactory bulb. A loss of about ¾ of the olfactory fibers occurs by age 80 or 90. Alterations in nasal anatomy and physiology also occur with age. There is loss of flexibility and elasticity of skin, decrease in thickness of subcutaneous tissue, atrophy of nasal musculature, thinning and weakening of cartilage; and brittle bony structure. Nasal mucosa becomes dry and secretions become thicker, resulting into less effective mucociliary systems.

The age-related hyposmia/anosmia adversely affects the quality of older people's life due to decrease in the ability to detect foul-smelling additives such as natural gas leaks; overuse of perfumes; and alterations in social interactions.

Touch

The threshold for the sensation of touch is increased with age. It may occur as a result of age-related changes in some of the touch receptors as well as dorsal columns. It has been reported that when the dorsal columns are destroyed, vibratory sensations and proprioception are reduced, the touch threshold is elevated, and the number of touch-sensitive areas in the skin is decreased.[86] In addition, localization of touch sensation is impaired. This poses a problem in recognizing the stimuli. The decreased sensory input contributes to functional impairments of elderly. For example, degenerative changes in Meissner's corpuscles results into a decrease in the sensitivity of the skin on the palm of the hand and sole of the foot. As a consequence, the older person has difficulty to button a shirt or to recognize simple pressure from a stone in the shoe.

VESTIBULAR SYSTEM

The vestibular system assists the motor system in maintaining equilibrium by providing a continuing inflow of information into the nervous system relating to the effects of movement and the gravitational forces upon the body.[54] The utricle and the saccule, also called static vestibular receptors, are responsible for transforming the forces associated with the change of position of the head with respect to gravity whereas the semicircular canals sense the velocity of head movement. This information is then correlated with visual and proprioceptive inputs, in order to control and modulate posture, balance and other motor activity.

Many age-related changes have been documented in vestibular system. There is 20 percent decline in hair cells of the saccule and utricle and a 40 percent decline in hair cells of the semicircular canals.[55] There is also reduction of neurons in scarpas ganglion and nerve fiber in vestibular nerve. Central vestibular system also undergoes degeneration with age. Disequilibrium associated with aging is known as presbyastasis. It is diagnosed when all other pathologies have been ruled out. All physiotherapists in geriatric clinics should remember that age-related decline in vestibular system could be responsible for dizziness and falls- the two most common problems in elderly.

CHANGES IN OTHER SYSTEMS (ORGANS)

- *Gastrointestinal system*: Digestive and elimination processes are less efficient in elderly. Reduced motility results into constipation.
- *Renal system*: Loss of nephrons, reduced glomerular filtration rate, and reduced tubular function are some of the age-related changes that occur in the renal system. The clinical consequences of theses changes are impaired fluid balance, increased risk of dehydration/ overload and impaired excretion of urine.
- *Lower urinary tract (LUL)*: With age, there is increased prevalence of involuntary detrusor (bladder muscle) contractions; increased nocturnal diuresis; impaired detrusor contractility; decreased urine flow rate; urethral shortening and decreased elasticity in women; prostate hyperplasia and hypertrophy in men.
- *Skin*: Skin heals more slowly as we age. The fat under the skin starts to get thinner and less stretchy, due to which skin becomes thinner and tears more easily; gets loose and starts to sag; with age, skin develops spots and moles; and loses the layer of oil on the outside that holds in water. In addition, elderly perspire less, which does not keep the body cool in the heat. (Refer Fig. 2.2).

Fig. 2.2: Difference between the skin of young (left) and older person (right)

- *Immune system*: Immune system becomes less efficient, making it more difficult for the elderly to fight off diseases. A decline in immune function occurs predominantly in cell-mediated immunity.
- *Endocrine system*: Endocrine system also exhibits the deterioration in its function. For example, reduced tissue sensitivity to insulin results into the increased risk of impaired glucose tolerance.

To Summarize

To summarize briefly what we know about aging, it is clear that organs deteriorate and become less efficient as individuals age. A consequence of this is that increasing chronological age brings with it an increasing probability of disease, disability and ultimately death of a person. However, aging is not that simple; it is rather far too complex and probably does not have a single cause. No matter how complex, physical therapist should use this existing knowledge of aging process to understand thoroughly how to help elderly achieve functional independence.

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3 Physiological Response to Exercise in Elderly

- **Cardiovascular System**
- **Respiratory System**
- **Musculoskeletal System**

Exercise or physical activity is a ubiquitous physiological state, so common in its many forms that true physiological "rest" is indeed rarely achieved. Defined ultimately in terms of skeletal muscle contraction, exercise involves every organ system in coordinated response to increased muscular energy demands. The magnitude of this response depends on several factors such as age, sex, initial fitness status and the specific type of training. Let us discuss the response to exercise involving the coordinated interplay between the physiological systems, especially, cardiovascular system, respiratory system and musculoskeletal system in elderly individuals.

CARDIOVASCULAR SYSTEM

The Physiological response of cardiovascular system to exercise may be considered as either central or peripheral in origin. Central adaptations with exercise training include changes in cardiac output, blood volume and arterial oxygen-carrying capacity whereas skeletal muscle blood flow and capillarization are the peripheral adaptations. Improvements in submaximal endurance capacity and the greater ability to tolerate higher levels of physical activity are important training adaptations. For improvements in cardiovascular fitness, the American College of Sports Medicine recommends an exercise intensity of 55/65 to 90 percent of MHR or 40/50 to 80 percent of heart rate reserve(maximum heart rate minus resting heart rate). ACSM further recommends accumulating 20 to 60 minutes at that level three to five days a week. The lower ranges are for unfit or even frail individuals who are about to begin an exercise program. A brief discussion of exercise induced changes in cardiovascular system in elderly is as following:

1. In comparison to younger individuals
   - *Maximum oxygen consumption*: Over the past ten years, it has been learnt that older persons can adapt to a program of regular aerobic training as well as their younger counterparts. Older adults can achieve the same 10 to 30 percent increase in VO_2max in response to endurance exercise training as young adults. A 12 week exercise training

program on cycle ergometers at an intensity of 70 percent of heart rate reserve with a frequency of three times/week, increased max VO_2 from 26.6 to 31.9 ml/kg/min in 60-year-old men and women, compared with an increase from 45.6 to 51.1 ml/kg/min in a group of 20-year-olds[1]. Thus, absolute amount of improvement of 5.5 to 6.0 ml/kg/min in older individuals was similar to that seen in younger individuals, although max VO_2 was lower in the older group. Improvement in max VO_2 indicates parallel improvement in cardiac output reflecting the importance of central circulatory adaptations after exercise training.

- *Submaximal heart rate*: Submaximal heart rate is reduced in elderly after standard level of exercise.[2] Same kind of adaptations in young populations has also been reported in a study conducted by Saltin and his associates.[3] The reduction in heart rate during submaximal exercise after endurance training probably reflects a reduced sympathetic drive.

2. In comparison to age-matched sedentary individuals: Although, low intensity exercise elicits marginal changes, both low and high intensity regular exercise is effective in retaining the cardiovascular function in elderly individuals, when compared to age-matched sedentary subjects.[4] A comparative study for individuals of different ages indicated that the 50-year-old athletes had almost twice the max VO_2 of that of the sedentary 50-year-old individuals.[5] Thus, exercise reduces the amount of a decline in exercise capacities among the elderly.
3. *In comparison to previous years of life*: In a long-term study (study period = 10 years), it was observed that at age 55, previously active men had maintained the same values for blood pressure, body weight and max VO_2 as at age 45.[6] The training studies have even depicted the dramatic effects of exercise training on the preservation of cardiovascular function throughout life. For example, in a study of marathon runners, starting at age 4 for males and at age 5 for females up to age 86 for males and age 80 for females, it was reported that the rate of running for 26.2 miles was remarkable for individuals in their eighth decade of life.[7] The study is suggestive of the substantial improvement in exercise capacities of individuals who continue to train on regular basis as they grow older.

RESPIRATORY SYSTEM

When compared to cardiovascular and musculoskeletal systems, the extent of adaptation to exercise by the respiratory system appears to be very limited—

1. In comparison to younger individuals:
   The effects of exercise training on respiratory system of elderly persons are similar to that of the young adult, namely:
   - Resting pulmonary ventilation is unchanged after exercise training.[11]
   - Endurance training lowers the ventilation at submaximal workrates, mainly due to reduction in lactate and CO_2 production.[8]
   - Exercise training increases the maximal ventilation during exercise.[5]
2. In comparison to age-matched sedentary individuals:
   - Older endurance athletes have greater pulmonary functional capacity than sedentary peers.

- Exercise training reduces the breathlessness experienced by elderly, sense of exertion and the percentage of maximal ventilation used during exercise.[9] In contrast, the untrained elderly person breathes harder and faster during submaximal exercise, experiences a greater perceived exertion in relation to exercise and uses a higher percentage of maximal capacity to perform the same exercise.

3. In comparison to previous years of life:
   The athletes over the age of 60 have values for vital capacity, total lung capacity, residual volume, maximum voluntary ventilation, $FEV_{1.0}$ and $FEV_{1.0}$/FVC consistently larger than expected based on their body size.[10] This suggests that the measures of pulmonary functional capacity of active elderly persons are comparable with their previous years of young life.

MUSCULOSKELETAL SYSTEM

Musculoskeletal adaptations are probably most important from physical therapy perspective. Significant changes occur in muscular performance, body composition and skeletal system of elderly persons after exercise training:

1. *Muscular performance*: Given an adequate training stimulus, older adults can make significant gains in strength. Even frail, institutionalized 80- and 90-year-olds can be benefited from strength training.[12] In addition, the rate of strength improvement is similar to increases previously reported for young adults.[13] The important factors that determine strength improvements are also same in both younger and older individuals:
   - Duration: A 2 to 3 fold increase in strength can be accomplished in 3 to 4 months in the muscle fibers recruited in resisted exercise training in older adults. With more prolonged resistance training, even a modest increase in muscle size is possible.
   - Intensity: High-intensity resistances that use 70 percent - 80 percent of 1RM produce more predictable increases in shorter period of time, but low to moderate resistances also produce improvements.[14]
   - Type of exercise: Resistance training is much more effective in strength improvements than aerobic exercise such as cycling, swimming or jogging.
2. *Body composition*: Although it is common to see that most "normal" individuals grow fatter with increasing age, individuals who engage in heavy resistance training increase their lean body mass and decrease fat.[7] This healthy body composition is critically important for experiencing the joy that optimal health can bring.
3. *Skeletal system*: In view of the functions and age-related changes in bone, it is reasonable to believe that sufficient mechanical loading and muscular activity is required to improve and preserve bone strength in the locomotor system. According to the mechanostat theory,[15] the mechanical competence of bones is achieved and maintained by homeostatic mechanisms which adjust bone mass and architecture to control the strains produced by mechanical load and functional activity. Both aerobic-type activities and strengthening activities influence bone density.[14] The role of strength training in achieving the mechanical competence of bones and preventing osteoporosis may be further emphasized by observations that bone mass, muscle mass and muscle strength correlate with each other.[16] In addition, the effects of exercise and hormone replacement therapy on bones and muscles are similar.[17] Although, direct experimental evidence on the specific effects of strength training on fracture risk

remains largely unexplored, the resistance exercise may be the best single means of simultaneously modifying the key risk factors for osteoporotic fractures. In fact, it has been observed that when prescribed appropriately, the strength training could be a potential therapy to improve functional ability and quality of life in osteoporotic patients.[18, 19]

To Summarize

Thus, exercise studies indicate a high degree of trainability among older men and women with adaptations similar to younger individuals. Aerobic- or endurance-type exercise can help to maintain and improve various aspects of cardiopulmonary function. In addition, resistance exercise helps offset the loss in bone mass, muscle mass and muscle strength typically associated with aging. Together, these exercise adaptations greatly improve functional capacity of older men and women, thereby improve their quality of life and extend an independent living, as truly said by The Greek Physician Hippocrates,

"All parts of the body which have a function, if used in moderation and exercised in labours in which each is accustomed, become thereby healthy, well-developed and age more slowly. But if unused and left idle, they become liable to disease, defective in growth and age quickly."[20]

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4 Principles of Geriatric Assessment

- **Aims of Geriatric Assessment**
- **The Team for Geriatric Assessment**
- **Efficiency of Geriatric Assessment**
- **Components of Geriatric Assessment**
  - History taking
  - Physical examination
  - Functional status
  - Mental status
  - Emotional status
  - Laboratory testing

Although many of the principles of geriatric assessment may remain same as those for the younger patients, a clinical approach to elderly goes beyond a traditional medical history and physical examination. This may be due to a sharp increase in variation in function with aging. For example, a person at the age of 65 years may need the help of another person to perform one or more of activities of daily living (ADLs, such as bathing, toileting, dressing, eating, transferring) whereas 80 years old may perform ADLs independently. In general, all older adults are alike. Thus, the principles of geriatric assessment may encompass many different settings, structures and models of care. The assessment very much depends on a particular case being assessed.

AIMS OF GERIATRIC ASSESSMENT

Geriatric assessment is carried out to:

- better recognize common geriatric disorders
- plan an effective treatment program
- improve overall health and functional outcomes
- reduce vulnerability to subsequent illness
- provide better quality of life

THE TEAM FOR GERIATRIC ASSESSMENT

Interdisciplinary or multidisciplinary approach is a key to geriatric assessment. The team has many members such as physician to assess medical fitness, physical therapist to assess physical fitness, occupational therapist to assess vocational status, speech therapist to assess speech problems, psychologist to assess the level of depression, dentist to assess oral hygiene, audiologist to assess hearing loss, ophthalmologist to assess eyesight, nurse to assess the status of personal care, dietician to assess nutritional status and social worker to assess the involvement of a patient with family or the community. All of these members work together to develop a single treatment plan in the interdisciplinary team whereas in a multidisciplinary team individual members perform separate assessments, notes and treatment plans. Interdisciplinary approach is justifiable for a geriatric patient in nursing home, especially a frail old with multiple pathologies whereas in geriatric OPD multidisciplinary team with contribution of 4 to 5 members can produce a real picture.

EFFICIENCY OF GERIATRIC ASSESSMENT

Geriatric assessment is complex and time consuming. It is important to ensure that patient is not exhausted by the method of assessment. A number of simple geriatric screening instruments have been used in geriatric practice to make the assessment simpler, quicker and still efficient. One such instrument is displayed in Fig. 4.1. The abnormal responses are followed up with further testing or investigations, when necessary.

Problem area	***Screening measure***	***Abnormal response***
Mobility	Note down the time after asking the patient: "Rise from the chair, walk 20 ft, turn, walk back to the chair and sit down"	Unable to complete task in 15 sec
Physical disability	1. Have you had any falls in the last year? 2. Do you have trouble with the activities of personal care like bath, dress, toilet or eat? 3. Do you have trouble with light house-hold work like cooking or lighting? 4. Do you have trouble with heavy house-hold work like washing windows? 5. Are you able to go out for shopping or to see a family friend? 6. Are you able to do strenuous activities such as fast walking or cycling?	Yes to all six questions
Vision	Test each eye with Snellen eye chart, with glasses (if applicable)	Can't read 20/40
Hearing	Whisper short sentences at 6-12 inches	Unable to hear
Urinary incontinence	Do you have problems with urine leaks?	Yes to the question
Nutrition, Weight loss	Ask: "have you lost weight?" if yes, "how much?" Weight/BMI	Loss of 5 per cent BMI<21
Memory	Name 3 objects/ask to recall in 5 min Ask to put the numbers on a clock face and then to draw the hands of clock to show a specific time such as 5:30	Remember<3 abnormal clock draw
Depression	Ask: "Have you often been bothered by feeling sad or depressed?"	Yes to the question

Fig. 4.1: A simple geriatric screening instrument

COMPONENTS OF GERIATRIC ASSESSMENT

Performing comprehensive assessment in the form of different components is another way to increase the efficiency of geriatric assessment. These components are:

A. History taking
B. Physical examination
C. Functional status
D. Mental status
E. Emotional status
F. Investigations

Information regarding the components of geriatric assessment is collected in the "Physical Therapy Evaluation Performa" (Appendix-VI). Let us discuss these components in detail:

History Taking

Table 4.1 lists the guidelines with regard to history taking of the elderly. The efforts are made to collect full information under the following headings:

- *Subjective information and personal history*: Age, sex, education, occupation, socio-economic status, etc.
- *Chief complaints*: There may be more than one complaint reflecting the presence of multiple pathologies.
- *Present physical illness*: The speed of onset of illness, precipitating events.
- *Previous physical illness*: The presence of chronic diseases, previous surgeries or hospitalization.
- *Drug history*: List of prescribed and nonprescribed drugs taken by a patient, drug allergies.
- *Nutritional history*: Number of meals/day, contents of diet.
- *Family history*: The presence of major diseases in family, causes of death of family members.

Table 4.1: General guidelines with regard to history taking of the elderly

➢ Remember that the patient to be assessed is the elderly, having age-related changes in one or more body systems.
➢ Keep the pace slower than usual.
➢ Introduce yourself in the very start of history taking.
➢ Address each individual as per his/her preference. "Sir", "Madam", "Mr." or "Mrs." may be used rather than "Grandpa" or "Grandma".
➢ Adopt the most effective way of communication with the patient such as eye contact, gentle touch or loud voice.
➢ Do not discuss the case with the relatives or care taker to the question s as if he is not allowed to participate in the discussion. In other words, never ignore the presence of elderly.
➢ Ensure that patient can hear what is being said.
➢ Provide glasses if needed.
➢ Speak at eye level, facing the patient.
➢ Never treat the elderly as if he is a child.
➢ Respect elderly as an individual.

Physical Examination

It is an integral part of geriatric assessment. Physical therapist should make sure to check:

- Height and weight
- Orthostatic BP and pulse
- Edema
- Skin integrity, pallor
- Range of motion
- Muscle strength
- Sensory status
- Coordination
- Vision and hearing
- Oral cavity – no of teeth, loose teeth, caries

Snellen eye chart or Jaeger Card can be used for vision whereas to detect hearing loss, the therapist may whisper short sentences at the distance of 6 to 12 inches from behind the head. If needed, patient may be referred to a specialist for detailed check-up.

Age-related physiological changes and formulae should be taken into consideration during physical examination. For example:

Ideal Body Weight (IBW)

For males = 50 kg + (2.3 kg) (each inch of height > 5 feet)
For females = 45.5 kg + (2.3 kg) (each inch of height > 5 feet)

Lean Body Weight (LBW)

IBW = 0.4 (actual body weight – IBW)
Body mass index
Weight in kg/ (height in meters)^2 or Weight in lb/ (height in inches)^2 × 704.5

Functional Status

This is a vital component of geriatric assessment because the information collected through the present functional status of a geriatric patient can be used as a baseline to measure future declines in function and to plan treatment strategy that can ultimately lead to an improvement in the quality of life.

Four elements of physical functional status are needed to be evaluated thoroughly and carefully:

1. Basic self-care and personal hygiene activities of daily living (ADLs)
2. More complex activities essential to live in community (IADLs)
3. Balance
4. Gait

ADLs and IADLs are assessed on the basis of self-report. The commonly used screens are given in Appendix-I and -II. Modified performance-oriented mobility assessment (POMA) is used for the assessment of balance and gait (Appendix-III).

Mental Status

Physical therapist has a key role as a member of the geriatric rehabilitation team and as a resource for other caregivers for the older patient with cognitive impairments. The therapist needs to have adequate knowledge to assess mental status, so that she can work with maximal efficiency and also enjoy clinical interactions with elderly. The term "dementia" is commonly used to describe the impairments in mental status. The Mini-Cog assessment instrument is briefer and has reasonable test characteristics to indicate the presence of dementia (Appendix-IV).

Emotional Status

Many people get depressed at some time in their lives. However, in elderly, depression is the most common psychological problem. Geriatric depression scale (GDS) is used to assess the level of depression in elderly (Appendix-V).

Laboratory Testing

Clinical use of laboratory testing for geriatric assessment is a useful tool when combined with physical assessment. It should be remembered that because the laboratory values given in usual reference ranges are traditionally derived from middle-aged populations, some "abnormal results" are actually normal for elderly populations. For example, bacteriuria in the absence of infection is a common laboratory finding in the elderly which would be considered pathological in younger adults. The reasons why reference ranges change with age could be

- Age-related decline in the most organ systems
- Nutritional deficiency
- Presence of inflammatory processes such as rheumatologic illness, infection and non-rheumatologic malignancies

Thus, to properly assess the results of laboratory testing, the effects of aging on expected values must be considered. Table 4.2 displays such changes in some of the laboratory values.

Table 4.2: Age-related changes in laboratory values

Laboratory test	*Age-related change*
Hemoglobin, RBC count, WBC count	Unchanged
Erythrocyte sedimentation rate	Unchanged
Blood urea nitrogen	Unchanged
Creatinine clearance	Decreased
Serum cholesterol	Increased
Serum calcium and Serum iron	Decreased
Serum uric acid	Increased
Serum glucose	Increased
Serum vitamin B_6 and B_{12}	Decreased
Plasma vitamin C	Decreased
Triiodothyronine (T_3)	Decreased

To Summarize

A Physical Therapist must have a special set of knowledge regarding geriatric assessment to provide high-quality physical therapy care to elderly populations. Unfortunately because of the length and complexity of many of the geriatric assessment tools, it is usually not practical to use them in the busy clinical settings or to include them in the initial assessment when the patient is a frail elderly. Therefore, there is a great need for an assessment tool, which utilizes less time and provides the required information needed by the physiotherapist.

5 Principles of Geriatric Physical Therapy

- **Aims of Geriatric Assessment**
- **Geriatric Physical Therapy in Different Settings**
  - Geriatric physical therapy in acute care hospitals
  - Geriatric physical therapy in skilled nursing facilities
  - Geriatric physical therapy at home
  - Geriatric physical therapy in outpatient departments
- **Geriatric Physical Therapy Program**
  - Assessment
  - Goal-setting
  - Therapeutic intervention
    - Range-of-motion exercise
    - Stretching exercise
    - Mobilization exercise
    - Strengthening exercise
    - Aerobic exercises
    - Gait training
    - Orthotics
    - Electrotherapeutic modalities
  - Reassessment

AIMS OF GERIATRIC ASSESSMENT

Geriatric physical therapy has been identified as a physical therapy specialization in order to acknowledge the advanced-level skills of physical therapists who seek to address the unique medical and functional problems of older persons.[1] In 1992, "The American Board of Physical Therapy Specialties" certified Geriatric physical therapists for the first time. Geriatric physical therapists encounter a wide spectrum of elderly patients, ranging from those who are frail and institutionalized to those who are functionally independent but require attention in outpatient departments.

GERIATRIC PHYSICAL THERAPY IN DIFFERENT SETTINGS

The role of geriatric physical therapy is important in all care settings. Geriatric physical therapists are providing quality care to patients in multiple settings that include acute care hospitals, skilled nursing facilities, outpatient departments, rehabilitation centres, home health agencies and hospice settings. The over-all condition of a patient will decide the type of care setting.

Geriatric Physical Therapy in Acute Care Hospitals

This is particularly important for the elderly having multiple comorbid conditions. However, a patient with single event like stroke may also need acute care in hospital. The patient is usually monitored by the interdisciplinary team. Physical therapy should be started as early as the elderly is able to tolerate the therapeutic interventions, especially exercises. The early physical therapy intervention can prevent secondary functional loss and promote early restoration of function and thereby reduce the length of hospital stay. The patient should receive therapy for two hrs per day to have significant improvement.

Geriatric Physical Therapy in Skilled Nursing Facilities

A skilled nursing facility has staff and equipment to provide skilled nursing care and other health services. Geriatric physical therapist may provide her specialized services as an employee of a skilled nursing facility or as an independent contractor. Elderly patients who are not suitable for acute care in hospitals may be treated in a skilled nursing facility. The patient should be employed two half-hourly sessions of physical therapy per day. The treatment time may be increased after the reassessment of a patient.

Geriatric Physical Therapy at Home

Many patients prefer to have physical therapy at their home. Physical therapist may visit the patient for once or twice a day. The main advantage of this kind of provision is that it saves the time of caregivers. The caregivers do not have to bother to take a patient to physiotherapy clinic. However, there is a disadvantage in the sense that the necessary equipment can not be used at home.

Geriatric Physical Therapy in Outpatient Departments

Outpatient department is the best option for the patients having the transport facility. However, it is not the suitable option for the frail elderly. Easy access to equipment and peer interaction are the main advantages for the patients being treated in outpatient departments.

GERIATRIC PHYSICAL THERAPY PROGRAM

The geriatric population is unique in its wide variation from individual to individual in the effects of both aging and disease processes. The effective administration of Physical Therapy program can make the quality of life better for the patients belonging to this complex group. The important components of this program are:

1. Assessment
2. Goal-setting

3. Therapeutic intervention
4. Re-assessment

Assessment

A comprehensive geriatric assessment, as described in previous chapter, is often helpful before the initiation of a physical therapy program to assist with setting realistic goals with each patient. Nevertheless, modification in the assessment may be required in some specific cases. For example, assessment of communication skill is must while working with the older patient with cognitive deficits so as to know the difficulties of patient in problem solving and self-care.

Goal-Setting

Functional independence is the ultimate goal of physical therapy intervention. This is particularly important in geriatric care, because the presence of acute as well as chronic illness in elderly individuals is often associated with loss of day-to-day function. To achieve this long-term goal, a physical therapist should establish several short-term goals:

- To improve or maintain ROM of different joints. For example, a geriatric patient should have enough ROM at shoulder to dress up or to reach dishes in the cupboard.
- To improve or maintain strength and endurance of muscles. For example, the patient should have sufficient muscle strength to lift a jug of milk, to make a bed, to make chapatti or to wash clothes.
- To improve or maintain cardiovascular endurance so that a geriatric patient is able to do strenuous activities such as fast walk, cycling or swimming.
- To improve or maintain ambulatory status of a patient so that a patient can go to toilet or for shopping independently.
- To relieve pain. It has been estimated that over 85 percent of older adults have at least one chronic disease that may give rise to the feeling of discomfort or pain.[24] Acute pain following surgery is also becoming quite common in geriatric patients. The most common therapeutic interventions to relieve pain are exercise, orhtotics, heat and cold modalities; and electrical stimulating currents.[25,26]

Therapeutic Intervention

A number of physical therapy interventions may be employed in order to attain treatment goals:

- Range-of-motion exercise
- Stretching exercise
- Mobilization exercise
- Strengthening exercise
- Aerobic exercises
- Gait training
- Orthotics
- Electrotherapeutic modalities

Range-of-Motion Exercise

Flexibility decreases with age and joints become stiff with disuse or disease. One of the major complications of this old age problem is the development of contracture, which make it very difficult or may be impossible to straighten out a joint completely. Contractures can develop within one week of inactivity and because they are far easier to prevent than to correct, daily range-of-motion exercises are highly recommended.[3]

Range-of-motion exercise is a basic therapeutic technique in which muscles or external forces move the body segment in various anatomical patterns through the available range of motion. Thus, ROM exercise can be either active or passive.

Passive ROM is Indicated:

- When a patient is not able to do the movement voluntarily, e.g. after stroke
- When active movement is detrimental to healing process, e.g. acute cervical spondylosis
- When patient is advised complete bed rest, e.g. after acute MI
- When patient is too weak, e.g. frail and/or institutionalized elderly.

Therapeutic Benefits of Passive ROM

- To maintain ROM
- To prevent complications of inactivity or immobilization such as contracture formation, cartilage degeneration, deep vein thrombosis, etc.
- To preserve the proprioceptive and kinesthetic sensations
- To inhibit pain
- To induce muscle relaxation.

Procedure for Performing Passive ROM Exercise: (Fig. 5.1)

- Select the most comfortable position of a patient
- Use appropriate grasp to provide support as well as control the movement.
- Move the segment through the available ROM without eliciting pain.
- Do not force beyond the available range.
- Perform the movement smoothly and rhythmically.

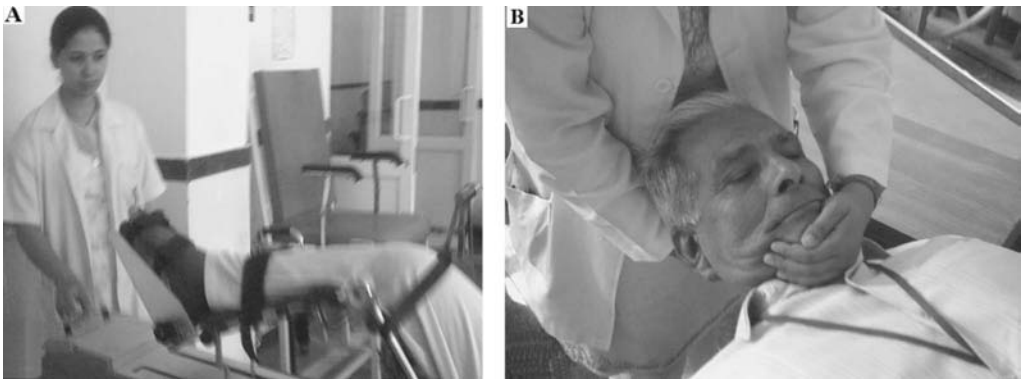

Fig. 5.1: Passive ROM exercise. **A.** Passive movements being performed on CPM
B. Passive movements being performed by a physical therapist

- No. of repetitions depend upon the condition of a patient. 5 to 10 repetitions are usually desirable.
- Passive ROM may be performed by a therapist or a mechnical device such as CPM.

Therapeutic Benefits of Active ROM

- To preserve joint function
- To maintain physiological elasticity and contractility of the participating muscles.
- To maintain and improve the range of motion
- To induce muscle relaxation, especially with the help of alternate and rhythmic movements.
- To decrease or inhibit pain.
- To increase circulation and thereby preventing DVT.
- To provide sensory feedback from the contracting muscles.
- To provide a stimulus for bone and joint tissue integrity.
- To improve neuromuscular coordination.

Procedure for Performing Active ROM Exercise: (Fig. 5.2)

- Demonstrate the desired movement in an appropriate manner.
- Ask the patient to perform the movement in a same pattern, but in pain-free or available range.
- External support may be given in case of muscle weakness. However, it should not substitute the muscular force exerted by a patient.

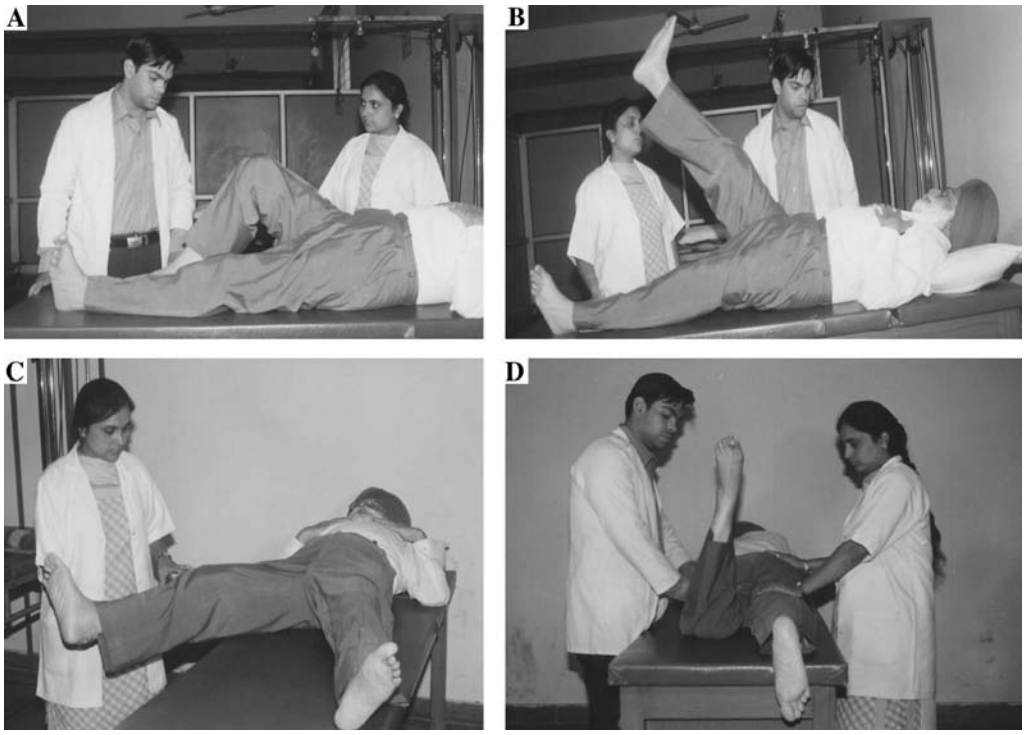

Fig. 5.2: Examples of active range-of-motion exercises. **A.** Knee flexion and extension supine **B.** Straight leg raising **C.** Hip abduction and adduction **D.** Knee flexion and extension prone

Contraindications

- Acutely inflamed joints
- Therapeutically fused joints
- Recent fracture

Stretching Exercise

In case of tightness of muscles and other soft tissues, ROM exercise is not much effective to lengthen the shortened structures; rather various types of stretching exercises should be incorporated in order to improve joint function.

Stretching is a general term used to describe any therapeutic manoeuver designed to increase mobility of soft tissues and subsequently improve ROM by elongating structures that have adaptively shortened and have become hypomobile over time.[9] There are many types of stretching exercise. The three most common type of stretching exercises are discussed here:

1. *Static stretching*: This is the most common method used as stretching technique. A static stretch places the muscle-tendon unit under a slow, gentle stretch that is maintained for a period of 20 to 60 seconds. This sustained stretching force reduces the intensity of the stretch reflex and depress the tone of the stretched muscle group. When it is carried out independently by a patient himself or herself, it is called self-stretching and when the stretching force is applied either by a therapist or a mechanical device, it is called passive stretching (Fig. 5.3).
2. *Proprioceptive neuromuscular facilitation stretching*: PNF stretching is the inhibition technique that attempt to reduce muscle tone by stimulating the golgi tendon organs. Thus, the technique produces relaxation of only contractile structures within muscle, and not the connective tissue within and around shortened muscle. This means that PNF stretching technique is applicable only if there is normal innervation and voluntary control of muscle to be elongated as well as its antagonist group. There are a number of techniques, but the most popular PNF stretching techniques is the hold-relax technique:
   – The muscle-tendon unit is slowly stretched to the end of the available range and held for several seconds

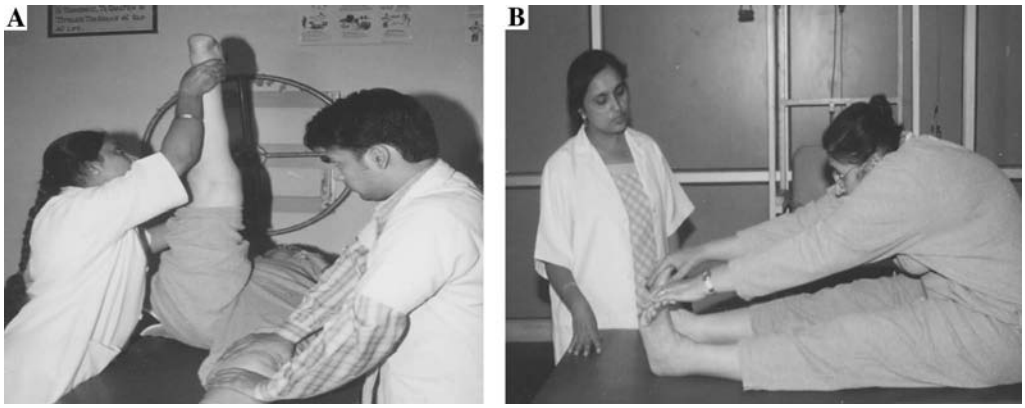

Fig. 5.3: Static stretching of hamstrings. **A.** Passive stretching **B.** Self-stretching

- Patient then performs a maximal isometric contraction against resistance and holds it for a period of 5 to 10 seconds.
- The muscle-tendon unit is then relaxed and slowly stretched further by a therapist.

The rationale behind this technique is that an isometric contraction with the muscle-tendon unit at its greatest length produces the maximum tension in the unit and thus, maximally stimulates the GTO. This causes reciprocal inhibition of the tightened muscle and allows it to be stretched further upon relaxation.

3. *Ballistic stretching*: This stretching technique involves rapid, forceful, repetitive movements through the joint's range of motion. The force generated by the vigorous, bouncing movements is used to overcome the resistance provided by the shortened structures. The technique is useful for improving ROM in young and healthy individuals. However, it is consistently contraindicated in elderly individuals or sedentary individuals or patients with presence of musculoskeletal pathology of chronic contractures because:
   - The high-velocity, high intensity movements are difficult to control.
   - Tissues weakened by immobilization or disuse, can be injured easily.
   - Dense connective tissue of chronic contractures does not yield easily with rapid stretch; rather it becomes more brittle and tears more readily.

Mobilization Exercise

Mobilization exercise is also a kind of stretching exercise used to improve range of motion. However, joint mobilization stretching techniques differ from other forms of passive or self-stretching in that they specially address restricted capsular tissue by replicating normal joint mechanics while minimizing abnormal compressive stresses on the articular cartilage within the joint.[17]

Therapeutic Benefits of Mobilization Exercise

- To stimulate the mechanoreceptors that may inhibit the transmission of nociceptive stimuli at the spinal cord or brain stem levels.
- To cause synovial fluid motion, this is the vehicle for bringing nutrients to the avascular portions of the articular cartilage.
- To prevent the painful and degenerating effects of stasis when a joint is swollen or painful.
- To elongate hypomobile capsular and ligamentous connective tissue.
- To mechanically distend the shortened tissue.

Technique of Mobilization Exercise

- Though mobilization exercises are relatively safe, they should be used with precaution in elderly patients.
- They should not be applied too vigorously. For example, application of thrust technique which is a high-velocity, short-amplitude movement, may results into joint trauma or hypermobility in older individuals.
- In elderly patients with weakened connective tissue, diminished circulation and osteoporotic bones; gentle mobilization techniques such as gliding techniques (Fig. 5.4) or joint distraction (Fig. 5.5) should be used within the tolerance of the tissue.

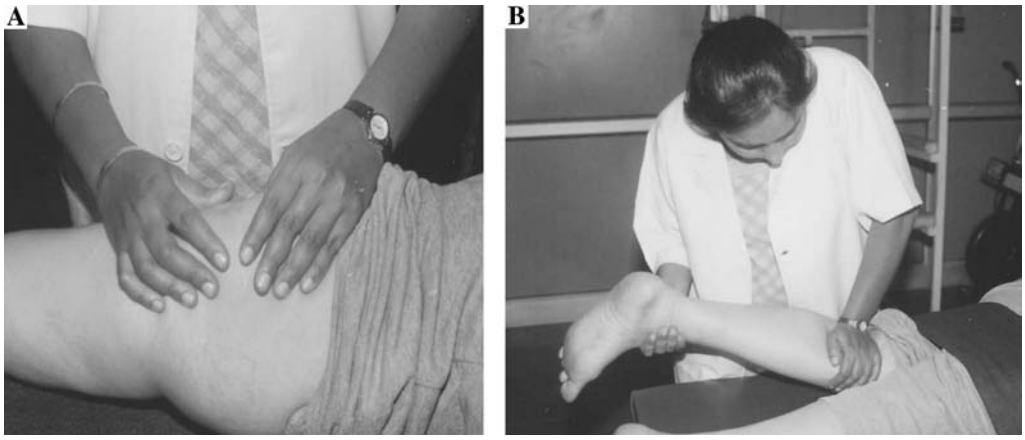

Fig. 5.4: Gliding techniques: **A.** Medial-lateral glide of the patella **B.** Anterior glide to knee joint

- Firm but comfortable stabilization of a proximal bone prevents undue stress to surrounding tissues and joints and makes the stretching force more specific and effective.
- Joint distraction is applied perpendicular to the treatment plane whereas gliding techniques are applied parallel to the treatment plane.

Strengthening Exercise

Strength is the ability of the muscle to generate a tensile force. This intrinsic force-generating capability is a prerequisite for performing many everyday activities. In other words, strength translates into good functional capacity and lessened disability. That is why the strengthening exercises are important and should be included in geriatric physical therapy program.

Therapeutic Benefits of Strengthening Exercise

- Hypertrophy of muscles involved in strengthening exercise.[10]
- Increased recruitment in the number of motor units firing as well as an increased rate and synchronization of firing.[11]
- The increase in the muscle strength which primarily occurs as the result of above adaptations namely increased neural activity and hypertrophy of muscles.[12]

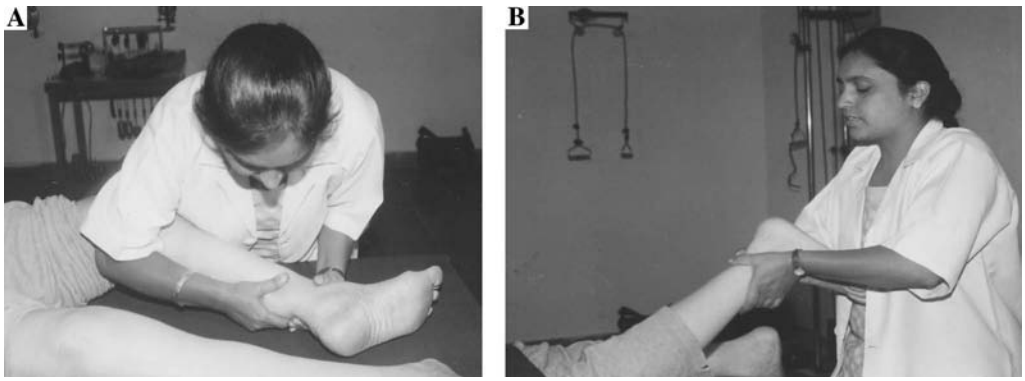

Fig. 5.5: Joint distraction applied to knee joint. **A.** In supine lying **B.** In prone lying

- Improvement in neuromuscular coordination which ultimately improves functional capacity because "functional strength" relates to the ability of the neuromuscular system to produce, reduce or control forces, contemplated or imposed, during functional activities, in a smooth, coordinated manner.[13]
- Improved carbohydrate and lipid metabolism which may be reflected as an increase in lean body mass and a reduction in percent body fat.
- Increased tensile strength of tendons, ligaments and connective tissue in muscle which helps in improving the stability of joints.
- An increase in bone mineral density may be attributable to the achievement and maintenance of the mechanical competence of bones.
- In addition to BMD, bone cross-sectional geometry and mass distribution may also change as a result of strength training and other treatments and thereby improve bone strength and reduce fracture risk.[14]
- The improved strength of muscles and bones, and stability of the joints lessen the amount of stress placed on the joints that are mostly affected by degenerative process in older adults.
- An improved bone strength in locomotor system helps in prevention of osteoporosis.
- In addition to changes in muscles and bones, strength training may improve balance and reduce the risk of falls as well as the intensity of the severity of fall injuries.[15]
- The some effects of all of these neuromusculoskeletal adaptations is the improved functional ability and quality of life of elderly individuals, from the most disabled to the most fit.

Considerations of Strength Training for Elderly Patients

- *Correct alignment*: Correct alignment is determined by the direction of muscle fibers and the line of pull of the muscle to be strengthened. For example, quadriceps strengthening should be done in high sitting position (Fig. 5.6D).
- *Appropriate stabilization*: Stabilization of part that is proximal to the joint to be moved is essential to ensure correct muscle action in an appropriate movement pattern and to avoid the trick movement which can otherwise occur, especially in case of muscle weakness or poor control over the joint movement.
- *Smooth movement*: The patient should be instructed to produce the movement against resistance at a steady rate without shaking or jerking.
- *Breathing guidelines*:
  - Start with taking a breath before lifting, exhaling during lifting and inhaling during controlled release
  - Avoid holding breath, otherwise internal body pressure will be increased.
- *Type of resistance*: (Fig. 5.6)
  - *Body weight*: For the very frail elderly, body weight offers sufficient resistance for initial training. Using body segment alone for strengthening exercise is similar to active ROM exercise. Progression can be done by performing exercises in different positions considering the effects of gravity. For example, hip abduction in supine lying and then in side lying will be a progression of movement in gravity eliminated position to movement against gravity or better said from grade 2 to grade 3, as described in Manual Muscle Testing. In addition to this, bearing the partial and then full weight of the body in standing, transfers, and walking also constitutes a strength training programme for many frail elderly patients.

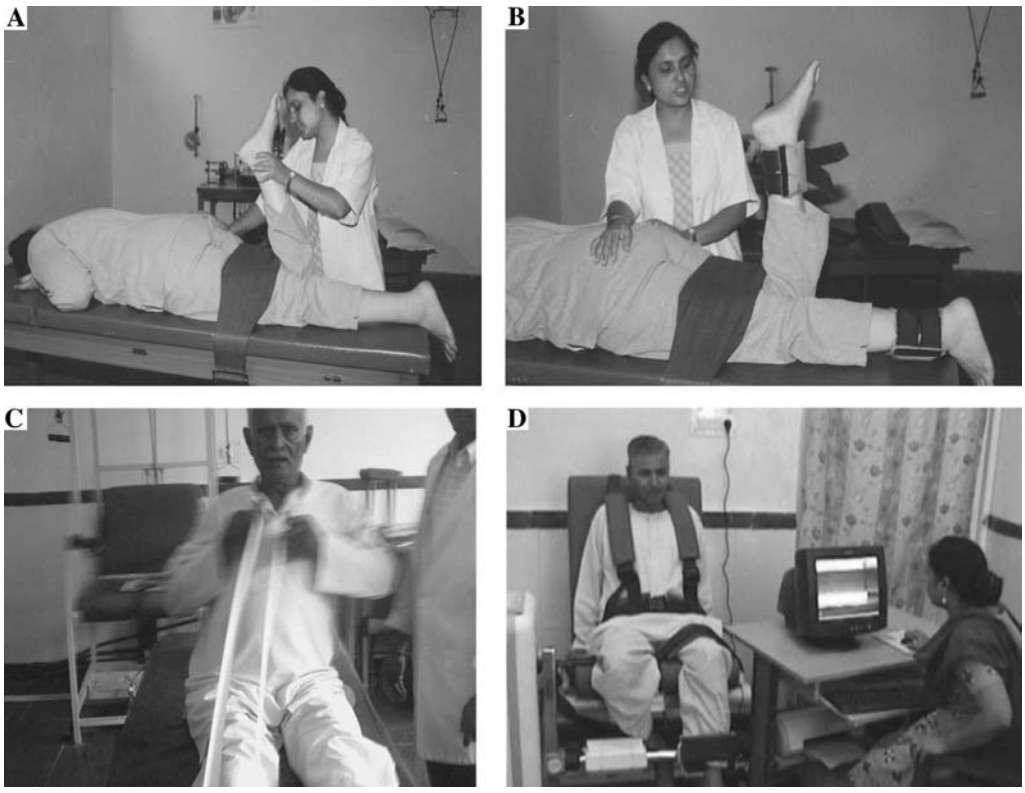

Fig. 5.6: Types of resistance. **A.** Manual resistance **B.** Weight cuff as resistance **C.** Elastic resistance **D.** Resisted exercise on isokinetic dynamometer

– *Manual resistance*: Manual resistance can be used as a progression in resistance training for those elderly patients who can tolerate their body weight very well but not the mechanical resistance. Rather it is the most effective form of strengthening exercise for transition from active ROM exercise to mechanically resisted exercise. The main disadvantage of this type of strengthening exercise is that the amount of resistance can not be measured quantitatively. However, an experienced physical therapist can very well judge the amount of resistance to be applied in order to gain maximum muscle works while protecting the healing tissues or supporting the weaker group of muscles. Manual resistance can be applied
  - to a single anatomical movement, e.g. shoulder flexion
  - in diagonal patterns associated with PNF techniques, e.g. shoulder flexion-adduction-lateral rotation
  - to a specific muscle as described in manual Muscle Testing, e.g. action of sartorious in high sitting.
– *Mechanical resistance*: The equipment for mechanical resistance ranges from simple to complex, compact to space-consuming or inexpensive to expensive. For most older

persons with clinical or subclinical disability, simple weight training equipment is probably sufficient. For example, elastic resistance (Fig. 5.10), free weights such as dumb bells, cuff weights, sand bags and simple weight-pulley systems. A computerized isokinetic dynamometer is the best example of the complex, space-consuming and expensive equipment. Nevertheless, it may be useful for in-depth evaluation of muscle performance or advanced-level resistance training in young-olds or when the muscle is required to perform the movement at a particular speed such as the speeds that are useful for functions like stopping a fall in middle-olds. In case of old-olds this equipment should not be used, as it may result into muscle soreness or inhibition.

- *Intensity of exercise*: For all types of elderly patients, the strengthening program should start with a baseline assessment of intensity. The most popular method of assessment is to find out repetition maximum (RM).
- *Frequency and duration*: For each level of intensity, sessions are repeated 2 or 3 times a week. A single session may consist of 3 sets of 10 RM with either progressive or regressive loading in each set. The former method is based on Delorme regimen whereas the later follows Oxford regimen. The level of resistance can be increased when 1 or 2 sets of repetitions are done in a smooth manner.
- *Rest intervals*: Elderly patients should rest from 1 to 2 minutes between sets in a same session. Rest period to a particular muscle or muscle group should be given by performing unresisted exercise such as low-intensity cycling or performing same exercise on contralateral extremity. This is because active recovery is more efficient than passive recovery for neutralizing the effects of muscle fatigue.[16]
- *Mode of exercise*: A strengthening exercise may be performed either statically or dynamically. Dynamic strengthening exercises result into the improvement of absolute ability to generate muscular force. However, functional strength is affected not only by the absolute ability to generate force but also by the ability to generate force across the varying lengths of the muscle during movement. Hence, the strengthening program should include dynamic exercises as well as static exercises at different points of range of available movement.

Aerobic Exercises

Aerobic exercises are endurance activities that do not require excessive speed or strength but do require demands on cardiovascular system. By participating in a supervised exercise program, the maximum amount of oxygen that the body can process for energy production during physical activity is increased. This, in turn, enables an individual to perform more exercise with less fatigue[3]. In addition, it is now generally accepted that aerobic exercise training can serve important protective and rehabilitative functions in elderly population.

Therapeutic Benefits Aerobic Exercise

- *Improvement in maximal cardiovascular functional capacity*: Research studies indicate that older people can increase VO_2 max with endurance exercise training to the same relative degree as young people, that is, 15 percent to 25 percent.[4, 5]
- *Improvement in the energy Level*: Several studies have shown that aerobic exercise is capable of improving the serum lipid profile by decreasing total cholesterol low density lipoproteins

(LDL) and triglyceride levels; increasing serum high density lipoproteins (HDL); and increasing the content of mitochondria, oxidative enzymes and lactate threshold, thereby increasing oxidative potential and the ability to perform endurance exercise.[6-8]

- *Improvement in the body composition*: Long-term aerobic exercise training results into reduction in fat mass and an increase in muscle mass. These are the prerequisite for the healthy body composition.
- *Reduction in disability*: Strong and lean muscles improve the stability of a joint and thereby reduce disability.
- *Psychological well-being*: Aerobic exercises lessen depression and improve physical self-concept and belief in self-efficacy.
- *Improvement of functional status*: Obviously, all of the above health-related benefits ultimately lead to improved capacity for the performance of ADLs IADLs.
- *Reduction in the risk of developing age-related diseases*: Mechanisms of protection is summarized in Table 5.1.

Table 5.1: Aerobic exercise: Mechanisms of protection against age-related diseases

Age-related diseases	*Mechanisms of protection*
Coronary heart diseases (CHD)	Improve myocardial circulation and metabolism to protect the heart from hypoxic stress
Hypertension	Reduces resting blood pressure
Atherosclerosis	Increases luminal diameter of coronary arteries
Non-insulin-dependent diabetes	Increases insulin sensitivity and glucose tolerance
Osteoporosis	Delays the decrease of bone mineral density

Research studies indicate that healthy older adults show no negative metabolic or hormonal responses or maladaptations to regular exercise that would contraindicate participation in a standard exercise training program. However, for a sedentary person with significant, undetected CHD, a sudden burst of strenuous exercise with its concomitant catecholamine release could place an inordinate strain on the cardiovascular system. This risk can be reduced considerably with proper medical evaluation that includes a thorough history, physical examination and stress testing.

Stress testing: Many different types of tests are available to collect the definitive information regarding performance capacity of the cardiopulmonary system of a patient. Age, ability to walk or run, and overall condition of a patient will decide which tool should be used for stress testing.

Treadmill tests: The Balke and Bruce treadmill tests are probably the most common used stress tests. Both the Balke and Bruce treadmill tests start at relatively high levels of exercise. Because of this, for men and women who are advanced in age or quite deconditioned, the modified Bruce or Balke test is used. Test protocol varies considerably in durations and size of work load increments. In general, a graded stress test should start at a low level and have increments in work load, approximately every 2 or 3 minutes. Usually one variable is kept constant while the other is increased incrementally, but, several treadmill protocols involve simultaneous increases in both speed and gradient. ECG monitoring should be performed during the testing. VO_2 max is determined when the oxygen utilization plateaus despite an increase in work load. The value

is usually considered to be maximal, since it requires contribution from the body's major muscle groups and usually results in central rather than peripheral fatigue. Test durations can be between 5 and 15 minute. In fact, test duration longer than 15 minute is not required, as most important cardiac and physiologic data can be obtained within this time period.

- Cycle ergometer tests: Cycle ergometers are of two types:
  - electronically braked ergometers
  - mass-loaded, friction type ergometers

  Power output is usually expressed in kgm/min or in watts (1 W = 6.12 kgm/min). The commonly used protocols are consisted of 2- to 4-min stages of graded exercise with an initial resistance between 0 and 15-30 W, increment by15-30 W per stage. The oxygen consumption is calculated by using following formula:

$$VO_2 = W \times 12.24 + 250/\text{body weight}$$

  Cycle ergometer tests should not be used if patient has quadriceps weakness, knee or leg pain, and poor coordination. However, there are many advantages of cycle ergometer tests over treadmill tests:
  - Cycle ergometer is safe, portable and relatively inexpensive
  - Patient's body weight is well supported.
  - The results of testing are independent of patient's body mass, easily calculated and regulated.
  - A greater sense of security is there, as test can be terminated by a patient rather than a therapist.
  - Test is most suitable for an elderly patient who is fearful of a continuously moving treadmill belt, has a history of dizziness or joint pain while walking.
- One-mile walk tests: Patient is asked to walk continuously for the distance of one mile, at a "brisk" speed. Time required and heart rate are recorded only for the final quarter of a mile. VO_2 max is calculated from the following formula:

$$VO_2 \text{ max} = 6.9652 + (0.0091 \times \text{wt}) - (0.0257 \times \text{age})$$
$$+ (0.5955 \times \text{sex}) - 0.2240 \times T_{1/4}) - (0.0115 \times HR_{1/4})$$

  Where wt = bodyweight in lbs
  Age = in years
  Sex = 0 for females and 1 for males
  $T_{1/4}$= time in min to complete the final ¼ mile
  $HR_{1/4}$ = heart rate at the end of the final ¼ mile

The exercise program: Aerobic exercise programs for preventive purposes as well as for rehabilitation are most effective when they are individualized. In general, the program consists of three important components:

1. Aerobic warm up: (Fig. 5.7)
   Duration:
   - About 5 to 7 minutes

   Indications:
   - To limber up the body
   - To reduce the chances of injury

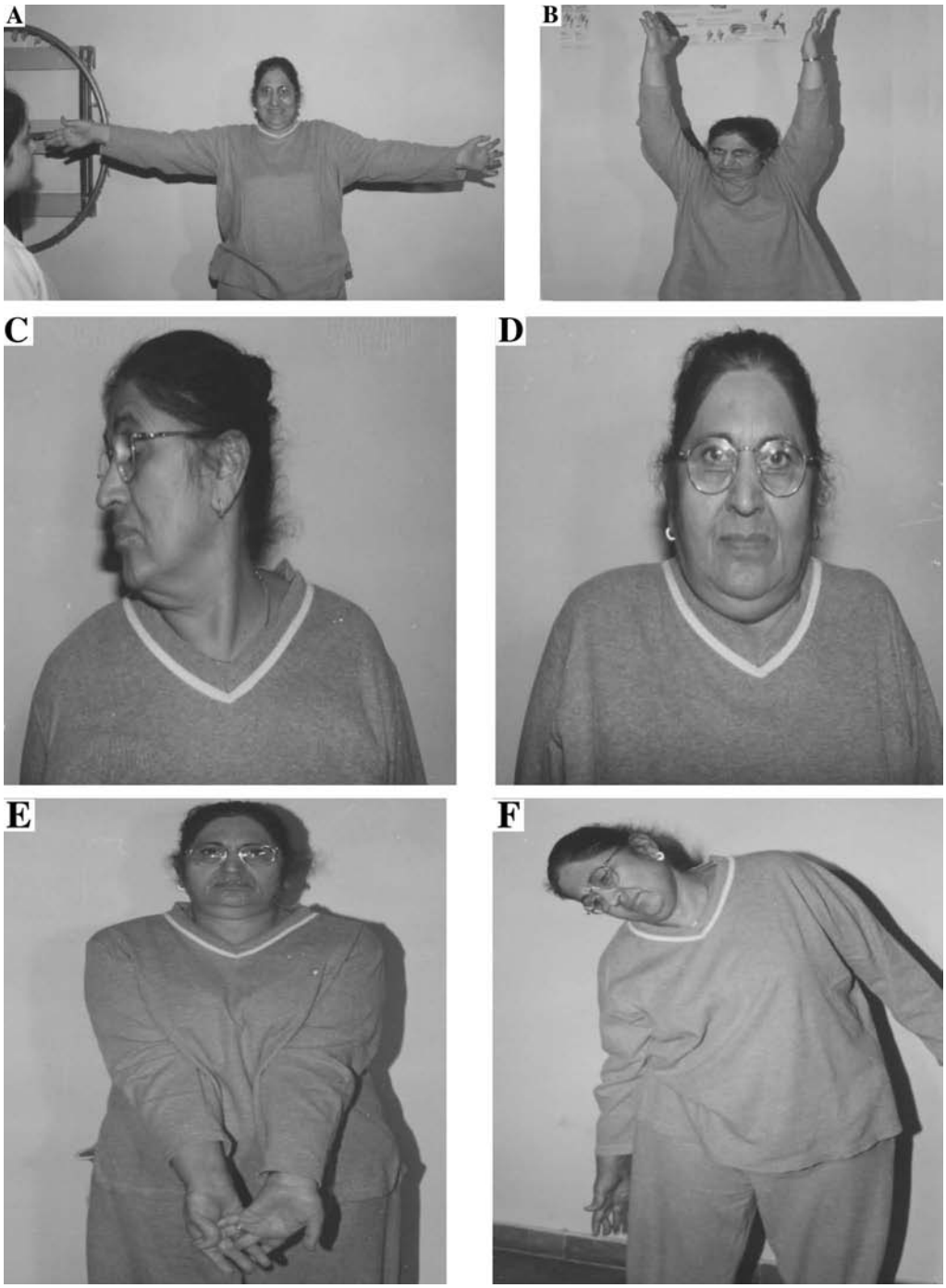

Fig. 5.7: Aerobic warm up. **A.** Sideward elevation of arms **B.** Forward elevation of arms **C.** Neck stretch-chin to shoulder **D.** Shrugging of shoulder **E.** Biceps stretch supinated F. Side bends

Fig 5.8: Cycling as aerobic exercise

2. Aerobic exercises:
   Protocol:
   - *Mode*: Cycling (Fig. 5.8), swimming or brisk walk are the common examples
   - *Intensity*: 60 percent of MHR
   - *Duration*: 30 minutes
   - *Frequency*: 5 days in a week.
3. Cool down:
   Duration:
   - About 10 minutes

   Indication:
   - To expedite the recovery process after aerobic exercises
   - To prevent injuries

   Protocol:
   - Slow walk for 5 minutes
   - Exercises already included described under the subheading of aerobic warm up

Gait Training

The ability to walk at an adequate speed for a reasonable time without undue fatigue certainly contributes to a comfortable and independent life.[2] However, in the older population, gait may be influenced by age-related changes, sedentary life-style or the presence of acute or chronic conditions. The age-related changes in gait are:

- Slower velocity, although ability remains to voluntarily increase speed from free to fast gait
- Decreased stride as well as step length, but steps are usually symmetrical
- A wider base of support, step width 1-4 inches
- Mild decrease at push-off results into less toe clearance
- Flat foot heel strike could be due to decrease in ankle dorsiflexion
- Decreased pelvic rotation, 8 to12 degrees

- Less trunk counter-rotation
- Increased shoulder extension and elbow flexion
- Increased hip abduction and greater toeing out
- Less vertical projection of the trunk and pelvis at toe-off

The alterations in gait may be attributed to decreased strength of muscles, increased stiffness of joints, reduced control of postural sway along with decreased force production in the postural extensors and plantarflexors. The increased shoulder extension may be a mechanism to counterbalance the increased kyphosis and forward head that move the center of mass anteriorly. In addition, the decreased speed of walking may be due to decreased cardiovascular endurance.

The purpose of gait training is to make a patient walk at functional speed. A thorough evaluation of gait is must prior to the beginning of gait training. During evaluation, the factors contributing the altered gait of a patient must be identified so that the effective treatment strategies can be worked out. Table 5.2 displays physical therapy interventions that can ultimately improve gait of elderly patients.

Table 5.2: Physical therapy interventions to improve gait

Factors contributing the altered gait of a patient	*Physical therapy interventions*
Difficulty in rising-from-sitting	Place feet close to chair by flexing knees more than 90 degrees Bend forward in sitting Push from chair Strengthening of triceps and latissimus dorsi Adaptation of height of chair
Increased thoracic kyphosis with flexion in lower cervical spine and extension in upper cervical spine	Correction in cervical spine position in sitting Postural control training Visual feed back in standing Hold and relax
Unequal weight distribution	Weight shift in all directions-forward, backward, sideways-for equal distribution in standing Decreasing the size of support, e.g. alternately raising on toes and heels Standing on a balance board Eccentric contractions of quadriceps and gluteals Biofeedback
Increased stiffness and/or tightness of soft tissues in trunk, hip knee and ankle	Suitable heat modality Joint mobilization with precaution in case of osteoporosis Hold and relax Passive stretching or self-stretching
Difficulty in maintaining weight-bearing postures	Rhythmic stabilization Standing on different types of surfaces like foam, concrete to alter sensory input Standing with eyes closed Isometric contractions of the postural extensor muscles in shortened range against resistance Assess foot-wear; hard-sole, well fitted, lace-up shoes with thick, absorbent socks are preferred

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Factors contributing the altered gait of a patient	*Physical therapy interventions*
	Recommend walking aid according to deficits and needs of a patient
Foot clearance problems	Faradic stimulation to ankle dorsiflexors
	Hip hiking in parallel bar
	Weight shifting to forward and backwards
	Ankle mobilization to increase DF
	Strengthening of ankle dorsiflexors
Difficulty with reciprocal swing of legs	Trunk rotation on mat
	Trunk twisting in sitting and standing
	4-point gait drills
Decreased strength of muscles	Resisted exercises with therabands or weights
	Training on isokinetic device
	PNF techniques
Decreased cardiovascular endurance	Administration of aerobic exercises in graded manner
Decreased push-off	Strengthening of plantar flexors
	Ankle mobilization to increase PF
	Standing on toes.

Orthotics

Orthotic devices are often indicated as a component of the treatment program of geriatric patients. Successful orthotic intervention requires a team work with a physical therapist and an orthotist as its key members. The responsibility of a physical therapist is to identify abnormal positions and movements that are responsible for pain, malalignment of body segment, difficulty in maintaining weight-bearing positions, unequal weight distribution and gait deviations. This functional information provided by a physical therapist establishes the primary problem area, on the basis of which, an orthotist fabricates the orthosis in order to improve functional status of a geriatric patient. Thus, the indications of an orthosis are:

- To provide immobilization or to control movement
- To support a weakened structure
- To correct anatomical alignment
- To assist motion to improve body function
- To alter the motion
- To reduce pain
- To promote ambulation
- To prevent deformity
- To relieve pressure on areas undergoing exacerbated forces or repetitive stress.

Principles of Orthotic Intervention in Elderly Patients

- There should be a practical balance between the objectives that are ideally desired and the tolerance of elderly patients.
- The basic principle of orthotic intervention refers to the application of forces or pressure to the involved body segments. However, elderly individuals are usually less tolerant of the aggressive forces, probably because of age-related changes in their skin and subcutaneous tissues.

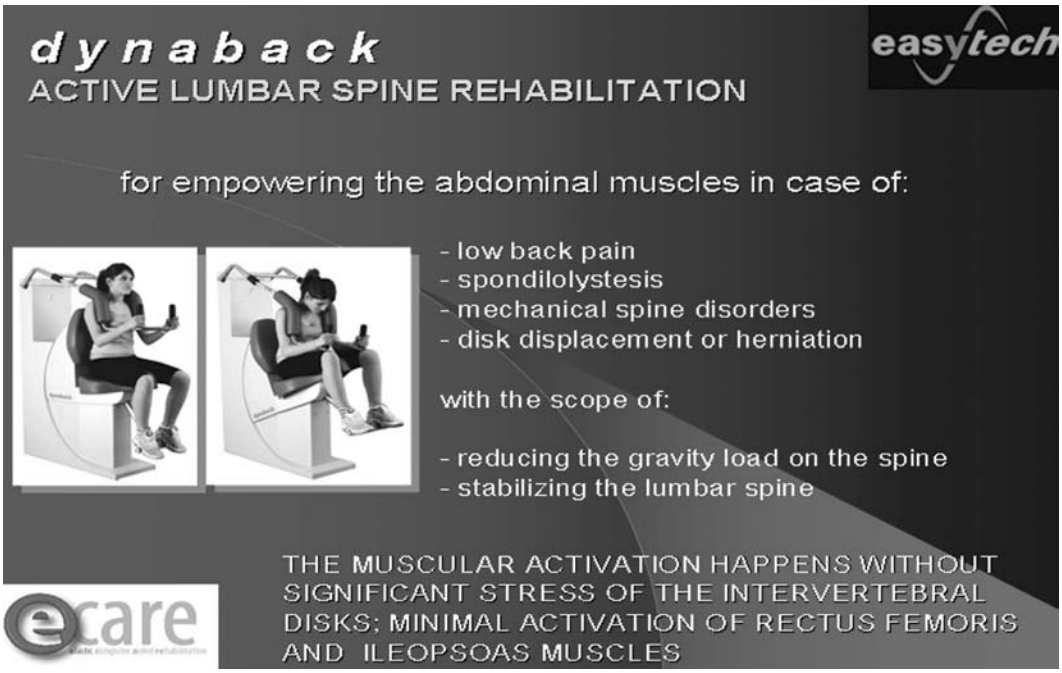
Fig. 5.9: Knee brace with polycentric knee joint made of aluminium alloy and neoprene padding

- As a rule, less is the force exerted by a patient to carry out the activity; more is the biomechanical efficiency of an orthotic intervention.
- Comfort and tolerance are the important considerations while designing an orthosis for an elderly patient. In general, flexible accommodative orthotic devices are preferred for this purpose.
- A three-point pressure system utilizes two forces applied in a similar direction that are separated and opposed by a third force. This system is usually used to either immobilize the joint or support the body segment. Examples are Knee orthoses (KOs) and Knee-Ankle-Foot orthoses (KAFOs) used to improve the stability of a knee joint through immobilization.
- The main disadvantage of extremely rigid orthotics made up from acrylics and other thermosetting plastics, is that they do not give and so, tend to transmit impact forces rather than absorb them.
- On the other hand, the main advantage of these rigid orthotics is that they provide ultimate biomechanical control. For example, a rigid orthotic with a protective metatarsal pad may be the best solution to control excessive pronation instability in a patient who is tall and overweight, and ambulates for short distances with a shuffling, nonjarring gait.[22]
- However, attempting biomechanical control is not always appropriate in most of geriatric patients, probably because of the presence of functionally adapted bones and stiff joints in these individuals.
- Soft materials such as neoprene may be appropriate for controlling minor discomfort from arthritis or to encourage joint stability when a more rigid orthotic system is not tolerated (Fig. 5.9). In addition to it, these orthoses retain heat and act as a kinesthetic reminder. One such example is a neoprene ankle sleeve.
- The metal orthosis has little skin contact in comparison to total-contact nature of the plastic orthosis.
- The choice between a plastic and a metal orthotic system may depend upon the factors such as sensory status, volume stability (i.e., presence or absence of fluctuating edema), skin integrity and the degree of flexibility or rigidity in primary problem area. For example,

metal orthoses are more comfortable for the elderly patients who have fluctuating edema or poor skin integrity whereas plastic orthoses improve the ability to control the movement of involved area.

- In general, plastic orthosis is the choice in elderly patients. This might be because of its light weight, better cosmetic appearance and easy interchange among shoes.
- While deciding between AFO and KAFO, it should be remembered that although AFOs are well tolerated by the elderly individuals, KAFO is the choice in the presence of severe genu recurvatum or knee buckling, *genu varus* and *genu valgus*.
- Less severe knee problems may be managed using KO. However, its shorter lever arm may result into greater skin pressures that may not be tolerable by elderly individuals. Moreover, the KO tends to slide distally during use, probably because of the decreased tone of the leg muscles of these patients.
- Hip-Knee-Ankle-Foot orthosis (HKAFOs) are usually not recommended in elderly patients as they are cumbersome to wear. However, it may have to be used when rotation control of the lower extremity is required.
- A hip orthosis is commonly used with the elderly to restrict the movements of hip adduction and flexion, in addition to some restriction to hip rotation, following the dislocation of a hip arthroplasty.
- The principle of correcting spinal alignment is seldom applied to geriatric population because of restriction of spinal flexibility and poor tolerance of the required forces. This implies that flexible spinal orthoses are well tolerated by the elderly patients. Rather it has been reported that flexible spinal orthoses serve to limit motion by acting as kinesthetic reminders to volitionally restrict movement as opposed to exerting three-point pressure control.[23]

A



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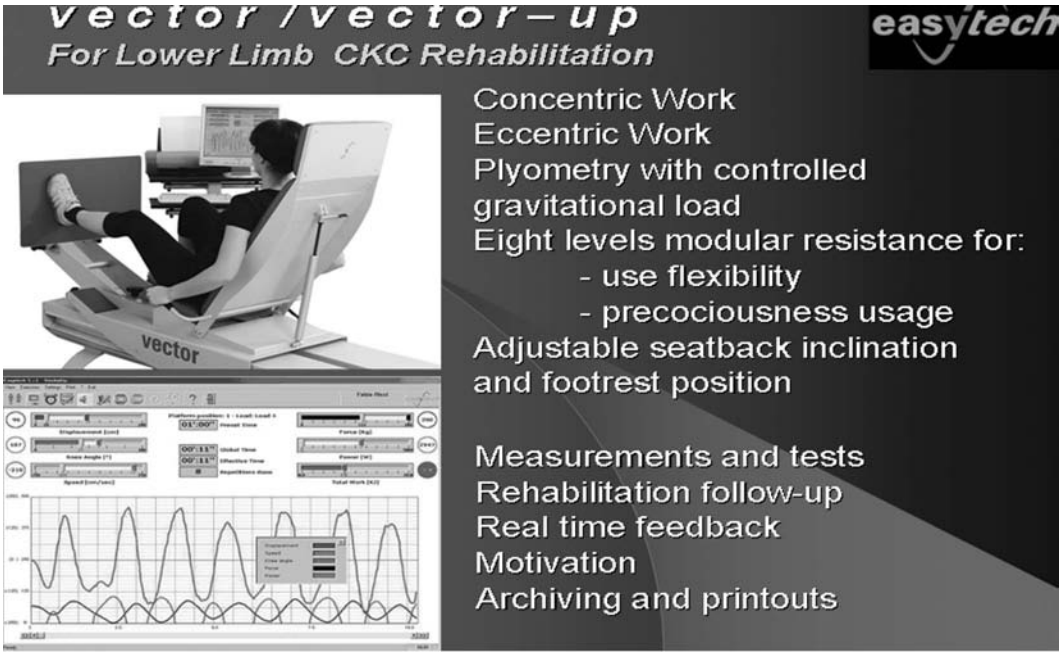

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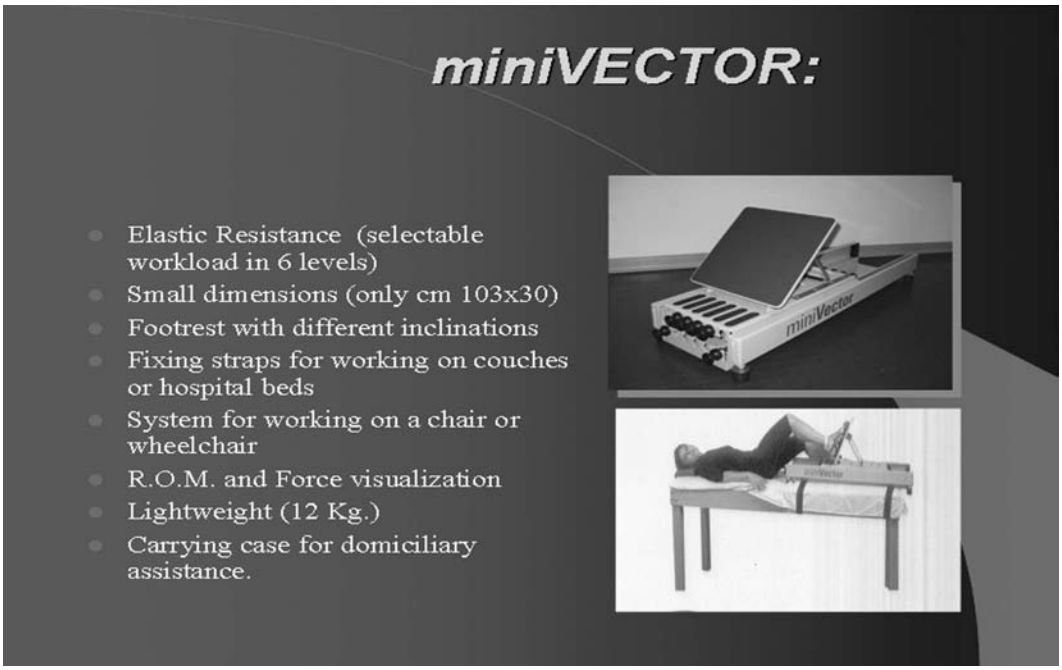

E

Figs 5.10A to E: Elastic computer aided rehabilitation equipments (Courtesy: BIO-MED INC. New Delhi)

Electrotherapeutic Modalities

Electrotherapeutic modalities encompass cold modalities, heat modalities, electrical stimulating currents and laser therapy to assist in the total program of geriatric physical therapy. Electrotherapy may contribute to tissue healing by minimizing continuing damage and facilitating repair; reducing pain and acting as an adjunct to therapeutic exercise; maintaining tissue health during enforced inactivity or improving tissue health during habitual inactivity. To achieve these therapeutic benefits, it is essential to apply the electrotherapeutic modalities at the appropriate dosage and frequency. Rather, all physical therapists working in geriatric clinical settings should remember Arndt-schultz Principle which states that stimulation beyond a threshold is necessary for a beneficial effect which will be dose dependent. At higher levels of stimulation the effect becomes inhibitory or progressively more damaging.

Cold Modalities

The application of cold modalities for the treatment of injuries and diseases is not a new concept. Even the ancient physicians used to recommend the cold to achieve therapeutic benefits. For example, cold spring water and snow water were used for stomach problems and other diseases such as gout, meningitis, ulcers, rheumatism, arthritis and swollen joints. Snow and ice were used long before there was artificially made ice. In the 18th century, ice was first produced in quantity artificially. However, it became commercially available not later than 19th century. The technologic advances in 20th century allowed greater clinical use of cold modalities.

Depth of penetration: Depth of penetration is from 2 to 4 cm depending on the amount of cold and the length of the treatment time.

Techniques of Cold Modalities

- Ice massage
- Ice packs
- Ice immersion
- Cold whirlpool

Treatment time: Recommended treatment time ranges from direct contact of 5 to 45 minutes to obtain adequate cooling.

Therapeutic Benefits of Cold Modalities

- Relieves pain by blocking the sensory transmission of pain impulses as a result of reduced nerve conduction velocity
- Reduces fever by significantly lowering the tissue temperature
- Controls bleeding by promoting immediate vasoconstriction and making the blood more viscid
  - Shorter period of application, if bleeding is on the skin surface
  - Longer period of application, if bleeding is deep in the tissues, forming an intramuscular hematoma
- Reduces edema
- Reduces inflammation through its effects on metabolism and circulation

- Reduces muscle spasm through its effects on muscle spindle
- Diminishes elasticity by increasing the stiffness of collagen
- Facilitates muscle contraction
- Allows increased ROM

Contraindications of cold modalities: Contraindications of cold modalities are based on the fact that cold produces vasoconstriction and decreases metabolism and neurofunction:

- Patients with cold allergies such as hives, joint pain, nausea
- The frail elderly patient as there might be unreliable thermoregulatory systems
- Confused patients
- Patient unresponsive from cardiac disease
- Raynaud's phenomenon, e.g. arterial spasm
- Sensory loss
- Peripheral vascular disease and circulatory insufficiency
- Arthritic conditions
- Some rheumatoid conditions
- Disliking of cold.

Heat Modalities

Examples of using heat for the medical purpose such as bathing in the warmth of the sun or lying in the warm sand can be traced back to the earliest time. However, it was not later than 20th century that the efficient and scientifically controlled heating modalities like whirlpool baths, hydrocollator packs, paraffin baths and infrared lamps came into existence. The penetration of heat with these modalities was limited to superficial tissues. In 1920s, the use of high-frequency electromagnetic currents made it possible to have a deeper form of heat modality, namely, Diathermy. With the further development in science and technology, high-frequency acoustic vibrations were used to develop ultrasound therapy in the early 1950s. Today, ultrasound is probably the most preferred technique for deep heating.

Mechanisms of heat transfer: There are four mechanisms by which the transmission of heat to body tissues occurs:

Conduction: It is the exchange of thermal energy between two surfaces when they are in physical contact with each other, e.g. hydrocollator packs.

Radiation: It is the process of heat transfer from a warmer source to a cooler source through the conducting medium, e.g. infrared lamps.

Convection: It is more rapid process than conduction and radiation. Convection occurs when the temperature variation is created by the particles of either air or water across the body, e.g. whirlpool baths.

Conversion: It is the transformation of nonthermal energy into thermal energy, e.g. diathermy where electromagnetic energy is transformed into thermal energy whereas in ultrasound therapy acoustic energy is transformed into heat energy.

Therapeutic Benefits of Heat Modalities

- Vasodilatation because of inhibition of the sympathetic vasoconstrictive nerve fibers.
- Improved tissue healing in subacute stage of inflammation due to hyperemia resulting in an increase in the supply of oxygen, antibodies, leukocytes and phagocytes.

- Increased removal of metabolic waste that has been accumulated as a result of inflammatory process. This benefit is gained due to increased lymphatic and venous drainage.
- Reduction of stiffness by altering the viscoelastic properties of collagen tissue, resulting in an increase in extensibility or elongation of this tissue.
- Increased ROM especially when heat is followed by stretching and mobilization exercises. This is because of capsular laxity that results from elongation of collagen in the capsule of joints due to heating.
- Alleviation of muscle spasm through decreased muscle spindle activity
- Reduction in the intensity of pain. The mechanism underlying analgesic effect is probably related to the gate control theory of pain modulation.

Contraindications of heat modalities: Contraindications of heat modalities are based on the fact that heat produces vasodilatation, increased metabolism and increased permeability:

- Acute inflammation
- Acute trauma with resulting hemorrhage or hematoma formation
- Edema
- Existing fever
- Cardiac insufficiency
- Peripheral vascular disease
- The frail elderly patient as there might be unreliable thermoregulatory systems
- Patients undergoing radiation treatment
- Impaired skin sensation
- Malignancy
- Confused patients

Superficial heat modalities: As the name implies, these types of heat modalities produce superficial heating of body tissues. In fact, there is general agreement that none of the superficial heat modalities can have a depth of penetration greater than 1 cm.[18] Hydrocollator packs, whirlpool baths, paraffin baths and infrared lamps are the examples of superficial heat modalities.

Deep heat modalities: These modalities, namely diathermy and ultrasound, allow far greater tissue penetration than superficial heat modalities. Both of these modalities are conversion-type and use high-frequency currents to produce a temperature increase in human tissue to a considerable depth. However, diathermy is a type of electromagnetic radiation whereas ultrasound is a type of acoustic vibration. Moreover, diathermy, as a therapeutic agent may be classified as two distinct modalities – shortwave diathermy and microwave diathermy. The depth of penetration with microwave diathermy (5 cm) is a bit deeper than with shortwave diathermy (3 cm), probably because of energy being concentrated in one spot rather than spread out over a large area.[19] Nevertheless, the depth of penetration with ultrasound is much greater than with any of the electromagnetic radiations, e.g. at a frequency of 1 MHz, 50 percent of the energy produced may penetrate to a depth of 5 cm. Thus, when the target tissue is deeply situated, ultrasound is the modality of choice.

Description of superficial and deep heat modalities is given in Table 5.3.

Table 5.3: Heat modalities

Modality	*Therapeutic frequency*	*Therapeutic wavelength*	*Application*	*Treatment time (min)*	*Specific considerations in in elderly patients*
Hydrocollator packs (160 to 170 F)	3.63×10^{12} Hz	82,457 A	A pack of suitable size is applied over the part to be treated after being wrapped in a terry cloth towel, usually 6 layers	15 to 30	Peak skin temperature is reached in 7 to 11 min, regardless of the person's age. However, in case of elderly, comfort is more important, e.g. for the treatment of LBA, instead of lying prone patient may either lie in supine or sit in a chair with a pack behind the back. Extra toweling and close monitoring is needed in these cases, as the extra pressure can cause burns, especially over bony prominences.
Whirlpool baths (98 to 104 F)	3.22×10^{12} Hz	93,097 A	Immersion of either full body or an just extremity	15 to 20	Elderly patients can usually tolerate whirlpools to the extremities without complications. However, greater precaution should be taken during full-body immersion, as a faulty thermoregulatory control could easily lead to heat exhaustion or heat stroke
Paraffin baths (126 F)	3.32×10^{12} Hz	90,187 A	- Dip and wrap method - Dip and reimmerse method	20 to 30	The skin of older patients is usually thin and the temperature of this modality maybe too intense for them. Thus, the risk of skin burns is substantial, so it should be applied under strict supervision.
Infrared lamps Luminous IR Non-luminous IR	 1.04×10^{13} Hz 2.08×10^{13} Hz	 28,860 A 14,430 A	- The area to be treated is exposed and placed directly under the lamp - The warm, moist towels are placed on the area to be treated - Dry towels are used to drape the body parts not to be treated	15 to 20	- The glare from luminous infrared lamp may irritate the eyes of elderly patients, so, protection with shaded glasses or goggles or by blocking the light from the face is recommended.
Diathermy SWD	 22 m 11 m	 13.56 MHz 27.12 MHz	- Capacitor field method with pad electrodes or airspace plates - Inductothermy method with cable electrode or drum electrode		Cardiac pacemaker or metal implant, commonly found in elderly patients, is the most noticeable contraindication. A debilitated elderly patient may not tolerate strong generalized heating, so extreme precaution should is necessary.

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Modality	*Therapeutic frequency*	*Therapeutic wavelength*	*Application*	*Treatment time (min)*	*Specific considerations in in elderly patients*
MWD	69 cm 33 cm 12 cm	433.9 MHz 915 MHz 2450 MHz	The emitter is directed towards the part to be treated keeping the distance of 2.5 cm for smaller areas, and 10 to 15 cm for larger areas.	5-30 min	
Ultrasound	1.5 mm	1 MHz 3 MHz	-The head of US is applied directly over the skin of area to be treated with the use of coupling medium such as glycerine and mineral oil. -The head should not remain stationary as it can result into a rapid rise in tissue temperature, causing damage to the endothelial cells and blood vessels. -The irregular areas should be treated by under-water application of ultrasound. The head should not be in contact with the skin.	5-10 min	- Special precaution should be taken while treating implanted joints as some plastics selectively absorb US waves which may cause the component to be loosened. Moreover, the metal-tissue interface may be a site for concentration of US energy and possible burning. -The presence of pacemakers may rule out the use of US therapy in elderly.

Hyperthermia: The latest modality to be considered is hyperthermia which means strong, deep and controlled heating. Commonly utilized in Europe, this innovative technique may find a place in Indian therapeutic arsenal. Hyperthermia provides the electromagnetic energy at the frequency of 915 MHz with surface air cooling prototype. The biggest advantage is that it reaches the therapeutic temperature level (42-45°C) at the depth from 1 to 4 cm, keeping the skin temperature under 36°C. This is possible probably through the contemporaneous use of two different energy sources, as explained in Fig. 5.11. Contraindications are same as those of other high frequency heating modalities.

Considerations of Using Heat and Cold Modalities in Geriatric Patients

- Age-related changes in the physiology of circulatory and nervous system may seriously decrease the body's ability to respond to the application of heat or cold. Thus, it is always better to assess ability of the elderly patient to tolerate the changes in body temperature.
- The conditions like coronary heart disease, arthritis, peripheral vascular disease and diabetes are commonly found in elderly, especially after the seventh decade.[20] That's why it is essential to check the patient's history carefully for the presence of chronic diseases as well as the medications used by the patient which could alter the patient's response to temperature changes.

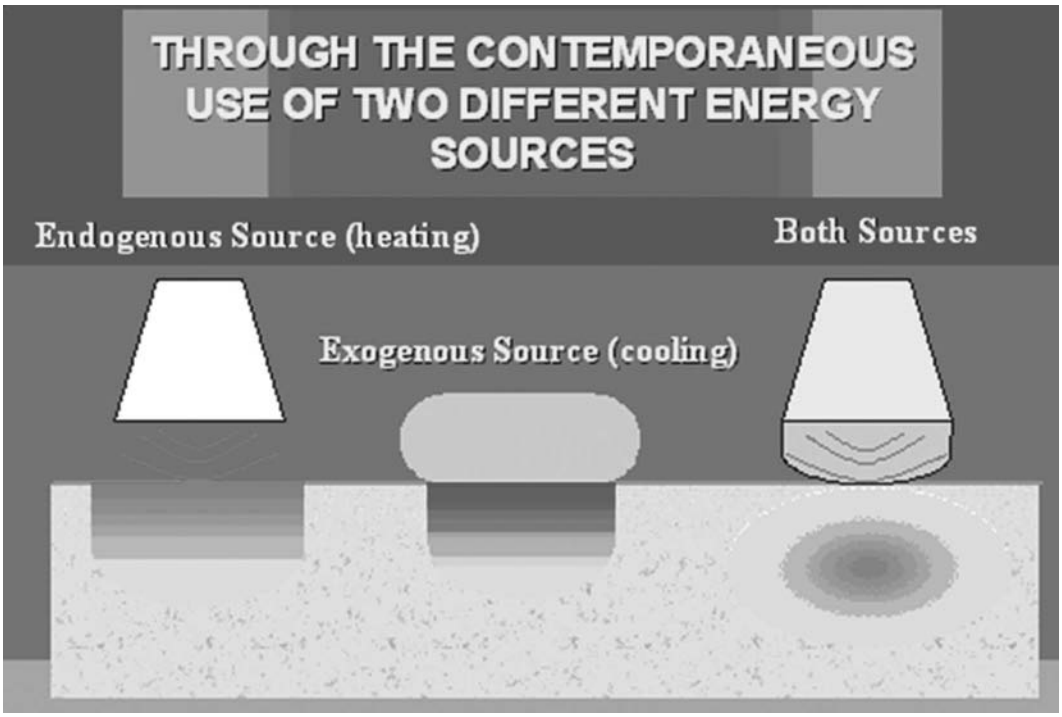

Fig. 5.11: Mechanism of production of heat in deep tissues by using thermotherapy technique

- In addition, the overall condition of the patient should be examined thoroughly, especially cardiovascular fitness, muscle tone and the skin integrity.
- Factors contributing to increased risk of thermal injury in elderly patients include decreased reactivity of the hypothalamic thermoregulatory system; decreased autonomic and vasomotor responses; impairments of the circulatory system; loss of sweat glands; atrophy of skin with reduction in circulation; lessened sensation of thirst; and decreased perception of thermal gradients.[21]

Laser Therapy

Laser is an acronym for Light Amplification by Stimulated Emissions of Radiation. It is a form of electromagnetic radiation which is classified as either high-power or low-power. High-power lasers, also known as "hot" lasers, are used in medical fields such as opthalmology, dermatology, oncology and vascular specialities; owing to their thermal effects. On the other hand, low-power lasers or "cold" lasers are used in the field of physiotherapy to have the beneficial effect on soft tissue and fracture healing as well as for the pain management through their photochemical rather than thermal effects. Two types of low-power lasers are commonly used: HeNe laser and GaAs laser. HeNe laser is a laser in red portion of electromagnetic spectrum, with a wavelength of 632.8 nm whereas GaAs laser is an infrared laser at a wavelength of 904 nm.

Depth of Penetration

- Depends on the type of laser energy delivered
- Absorption of HeNe laser energy occurs rapidly in the superficial structures, especially in the first 2 to 5 mm of soft tissue. It has indirect effect up to 8 to 10 mm deep into the tissues
- The GaAs laser has a direct effect up to 1 to 2 cm whereas indirect effect up to 5 cm.

Technique of Application

- Simple to apply
- Usually applied to the skin by a hand-held applicator which is about the size of a larger marker pen
- Three techniques of application are there:
  - *Direct gridding technique*: An imaginary grid over the target area composed of 1 cm squares is developed and laser is directly applied to each square for a predetermined time.
  - *Scanning technique*: Applicator is kept 1cm or less from surface of the wound. Energy decreases because of the beam divergence, as the distance from the target increases.
  - *Wanding technique*: Grid area is bathed with the laser in an oscillating fashion for the designated time. This technique is not recommended because of its irregularities and difficulty to calculate dosimetry.

Treatment time: can be calculated with the help of following formula:

$TA = (E/P_{av}) \times A$

TA = treatment time for a given area
E = millijoules of energy per cm^2
P_{av} = average laser power in milliwatts
A = beam area in cm^2

Therapeutic Benefits of Laser Therapy

- Promotes wound healing through significant increase in fibroblastic proliferation with subsequent increase in production of connective tissue
- An accelerated resolution of the acute inflammatory response through a decreased level of prostaglandin E and an increased capillarization
- Improves immunological response through increased phagocytosis by leukocytes and direct stimulatory influence on the T and B lymphocyte activity
- Relieves pain through significant decrease in sensory nerve conduction velocity, hastened healing, anti-inflammatory action, autonomic nerve influence and neurohumoral responses from descending tract inhibition
- Less scar tissue and a better cosmetic appearance through greater epithelialization and less exudative material, more regular alignment of collagen and smaller scars, increased circulation with the production of new blood vessels in the center of the wound and maintained viability of edges of the wound

Contraindications

- Over cancerous lesions
- Directly into eyes

It is always better to underexpose than overexpose, especially when laser is applied to elderly patients.

Electrical Stimulating Currents

There is an interesting history of the use of electric stimulating currents as a therapeutic modality. Scribonius Largus, a Roman Physician, described the use of electrical eels, rays and torpedo fish for the treatment of headache and gout. Later on, the use of animal was discarded, but the use of electricity as a therapy was continued and in the 1700s and 1800s numerous prototype generators were developed to produce electricity at the convenience of physicians. Throughout the 1800s and early 1900s a variety of battery-operated faradic devices came into the existence and were promoted to treat various conditions such as acne, abscesses, alopecia, anemia, asthma, constipation, lumbago and urinary incontinence. In 1965 Melzack and Wall postulated pain gate theory, establishing scientific basis of therapeutic benefits gained from electric currents. In the past 35 to 40 years the use of electric stimulating currents as a therapeutic modality has become much more sophisticated and wide-spread. Different types of therapeutic currents are described in Table 5.4.

Table 5.4: Therapeutic currents

Type of current	*Frequency with pulse duration*	*Application*	*Therapeutic benefits*
Direct current (Low voltage)	0 HzNo pulses	-Both electrodes are used over gauze that has been soaked in saline solution and lightly squeezed. - In case of iontophoresis, positive ions must be placed under the positive electrode and negative ions under the negative electrode.	-Promotion of wound healing through hyperemia, bacteriostatic effects under negative electrode, and migration and alignment of cellular building blocks. -Therapeutic effects of iontophoresis depends upon the nature of the drugs introduced into the tissues, e.g. anti-inflatory drugs in tendinitis or antibiotics in skin infection gives good results, as the treatment is highly localized directly to the needy area.
Surge faradic-type currents	50-100 Hz 0.1-1 ms	-A muscle performs individual action when stimulated at its motor point using a probe electrode. - Muscle groups such as quadriceps, small muscles of foot or pelvic floor are stimulated using both flat plate-electrodes.	-Reeducation of muscle in presence of muscle inhibition after surgery, injury or prolonged disuse -Improvement in muscle strength in patients with muscle weakness -Prevention or retardation of atrophy reduction of edema
Interrupted direct current	30/min 100 ms	-One flat plate-electrode may be fixed over the origin of the muscle group and each muscle is stimulated in turn with a probe electrode.	-Prevention or retardation of atrophy in case of denervation of a muscle - Reeducation of muscle in the early stages of re-innervation

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Type of current	*Frequency with pulse duration*	*Application*	*Therapeutic benefits*
		-Two flat plate-electrodes are used, fixing one electrode over each end of the muscle.	
Transcutaneous electrical nerve stimulation	2-200 Hz 10μs-400μs	Electrodes may be placed on the painful area or on acupuncture and trigger points or close to the spinal cord segment that innervates the painful area.	Alter the transmission of pain signals to the brain, minimizing or eliminating nac-cotic or other pain relieving drug depen-dency.
Interferential current	4 KHz	-Two pairs of electrodes are usually arranged in a criss-cross pattern in such a way that the interference effect, also called beat frequency, is produced in the painful area in the 1-100 Hz band. -Either a constant or rhythmic mode is used -rotating vector mechanism may be used to get a more uniform distribution of interferential currents in the tissues.	-Relief of pain by using a constant beat frequency in the range of 0 to 100 Hz. -Production of strong muscle contractions without any significantly uncomfortable skin sensation by using a constant beat frequency in the range of 0 to 10 Hz. -Absorption of exudates when a beat frequency of 1 to 10 Hz in a rhythmic mode is used. -increased fiber recruitment via rhythmic mode and precise localization with targeting tissues that are deeply situated are two additional benefits.

Considerations of using Electrical Stimulating Currents in Geriatric Patients

- Electrodes should be thoroughly moistened or adequately covered with transmission gel. Only electrical transmission-type gels should be used and ultrasonic preparations should be avoided.
- Electrodes should be secured in position with light-weight sandbags, non-conductive tape or velcro straps and tight, constrictive or moist strapping should be avoided.
- Never allow the full weight of the body or a heavy limb to rest on the electrode, as it may squeeze out the required moisture in the electrode, causing burns.
- Many elderly patients prefer sitting position rather than lying supine or prone. In any condition, most comfortable position must be selected with proper pillow supports for back, shoulders and popliteal areas. Moreover, dependent positions for upper and lower extremities should be avoided in the presence of circulatory problems.
- Treatment time of 10 to 15 min may be sufficient for elderly patients. This may contradict 30 to 45 min of stimulation in the younger, athletic type population.
- Current intensities should be kept minimal rather than maximal to get the desired results.
- "Visible contraction at patient tolerance" is always better in elderly than "maximum contraction" as it could be painful or irritating for them.
- Thin and dry skin of elderly people must be provided extra care to avoid skin irritation as well as the danger of burns.
- The chemical effects associated with direct current make it a current with "bite" and may negate its use in elderly. Skin burns are the greatest hazard, while using this current in elderly. In addition, caution is advised regarding hyperemia where vascular compromises are present.

- Any modality with a frequency of 500 Hz or more should not be used in the presence of a pacemaker. Thus, it may eliminate the use of electrical stimulation in general.
- Age-related changes in blood circulation, muscle strength and range of motion may provide practical limitations for the application of electrical stimulating currents. Thus, physical therapist may adjust the parameters according to individual needs of a geriatric patient.

Reassessment

There should be ongoing reassessment while administering geriatric physical therapy program. This enables a physical therapist to judge the effectiveness of treatment towards the goals set, with required modifications in the treatment strategies.

To Summarize

A variety of physical therapy interventions have been discussed in this chapter. It is the discretion of a physical therapist to tailor a program that is most suitable to the individual's needs and tolerance because one hallmark of aging is the "uniqueness" of each individual. Another problem in geriatric patient care is that the responses to therapeutic interventions may not be as clear as might be expected. Acknowledging this challenge, a physical therapist should administer physical therapy intervention in such a way that can support the sense of worth in a geriatric patient.

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6 Cardiorespiratory Disorders in Elderly

- **Cardiovascular Disorders in Elderly**
  - Acute myocardial infarction
  - Coronary heart disease
  - Arrhythmias and conduction disturbances
  - Hypertension
  - Congestive cardiac failure
- **Respiratory Disorders in Elderly**
  - Chronic obstructive pulmonary disease
  - Asthma
  - Pulmonary embolism

CARDIOVASCULAR DISORDERS IN ELDERLY

Cardiovascular disorders are the leading cause of death in elderly population throughout the world. The progressive increase in the prevalence of cardiovascular diseases with advancing age may be attributed to age-related changes in cardiovascular system and presence of cardiovascular risk factors such as physical inactivity, smoking, diabetes, hypertension and dyslipidemia in older populations.

Acute Myocardial Infarction

Age has a profound effect on the occurrence and outcome of acute myocardial infarction. In the United States each year, 62 percent cases occur in persons 65 years of age or older and 37 percent cases occur in 75 years of age or older. Silent acute MIs are more common in elderly and may account for 25 to 30 percent of all MIs in elderly. Mortality with acute MIs is approximately 35 percent, with slightly more than half of the deaths occur before the patient reaches a hospital.

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Signs and Symptoms

- > 50 percent of MI patients older than 80 may not complain of chest pain.
- The most common initial symptom in persons older than 80 is dyspnea or acute shortness of breath.
- Atypical symptoms such as arm pain, GIT disturbances, fatigue, dizziness, syncope, confusion, stroke, acute functional decline

Evaluation and Assessment

- The diagnostic approach in elderly is same as that of younger persons
- ECG changes may or may not be classical in some patients (Fig. 6.1)
- Definitive diagnosis requires documentation of cardiac enzyme rises
- Both creatine kinase MB isoenzymes (CK-MB) and cardiac troponins T and I usually become elevated 4 hr following myocardial injury
- CK-MB levels return to normal within 48 to 72 hr after MI onset
- Troponin may remain elevated for up to 2 weeks, especially in patients with larger MIs
- Serial enzyme measurements with a typical rise-and-fall pattern are necessary to diagnose MI

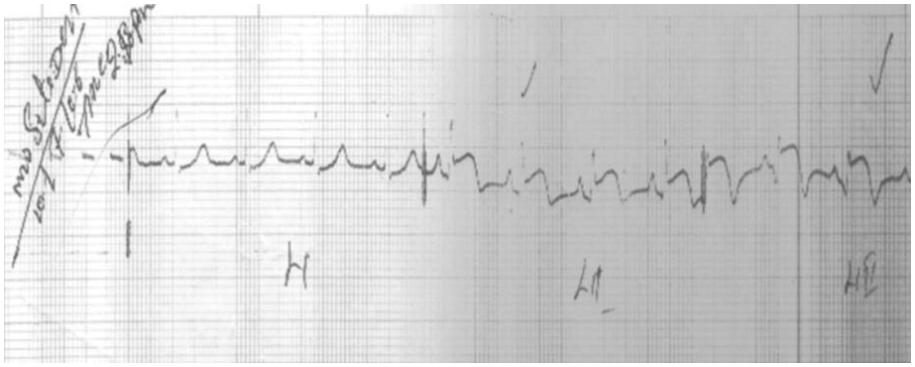

Fig. 6.1: ECG changes in myocardial infarction

Management

- General measures:
  - Oxygen to maintain arterial saturation ≥ 90 percent
  - Morphine for pain and dyspnea
  - Nitroglycerine for ischemia and heart failure
- Reperfusion therapy:
  - Fibrinolytic therapy for chest pain <12 hr, ≥ 1 mm ST-segment elevation surgery-percutaneous coronary angioplasty is associated with short- and long-term outcomes for ST-segment elevation or non-ST-segment elevation infarctions
- Pharmacological management:
  - Aspirin
  - Angiotensin-Converting Enzyme Inhibitors
  - Calcium channel blockers

- *Advice to patient:* (Table 6.2)

Fig. 6.2: The intensive care unit

- *Physical therapy:*
  According to guidelines laid down by the British Association of Cardiac Rehabilitation (BACR), there are four phases of cardiac rehabilitation:[4]
- *Phase I: The in-patient stay (Fig. 6.2)*
  Generally, the patient has to stay for 5 to 7 days in acute care setting. Physical therapy program is aimed at encouraging positive attitude, preventing complications such as chest infection or DVT and gradually improving activity level. A typical physical therapy program is given in Table 6.1. However, it should be remembered that all patients do not progress at the same rate. A strict supervision is needed for initial period.

Fig. 6.3: Physical therapist assisting a patient while taking a round in the room during cardiac rehabilitation: phase I

- *Phase II: The immediate postdischarge period*
  Week 2: Walk up to 0.5 miles
  Week 3: Light to moderate house-hold activities
  Visit to a friend or go for food outside
- *Phase III: The intermediate postdischarge period*
  Week 4: go to OPD to receive physical therapy
  Week 5: aerobic exercise for asymptomatic patients. Tolerance of exercise is more important than exercising at specific heart-rate intensity. Rest periods should be included at patient's discretion.
  Week 6 to 12: Gradual progression in duration, frequency and intensity of aerobic exercise.
- *Phase IV: Long-term maintenance:*
  Lifestyle modification within 6 to 12 months:
  - active lifestyle
  - healthy diet
  - psychological issues
  - weight control
  - smoking cessation
  - stress management
  - control of hypertension

Table 6.1: Physical therapy program during phase I

In-patient stay	*Physical therapeutic technique*
Day 1-2	Breathing and circulatory exercises
Day 3	ROM exercise in sitting, in addition to above exercise
Day 4	Sitting to standing – 4 to 6 times a day, in addition to above exercise
Day 5	Walk in room for two rounds, in addition to above exercise (Fig. 6.3)
Day 6	Increase the frequency and distance of walks
Day 7	Going up and down the stairs under supervision, in addition to flexibility and mobilization exercise

Table 6.2: Advice to patient

- Begin with gentle activities and progress to moderate intensity exercise gradually
- All strenuous activities, especially those involving work above shoulder height, should be avoided up to 6 weeks after acute MI
- Never work through chest pain
- Take rest, when necessary

Coronary Heart Disease

CHD generally involves degenerative changes in the intima of larger arteries supplying the heart muscle that results in progressive occlusion. Over last three decades, the mortality rate from CHD has come down; still it remains the leading cause of death in elderly population throughout the world. The prevalence of CHD usually increases with age, affecting 16.1 percent of women and 18.6 percent of men older than 75 years.

Signs and Symptoms

- Central chest discomfort is the most common symptom. Patient may complaint of pressure, heaviness or tightness in chest that is aggravated by physical exertion or emotional stress and relieved by rest or nitroglycerine.
- However, many elderly may not have this typical symptom, especially diabetics are asymptomatic. This may be due to sedentary life style of elderly.
- There may be presence of atypical symptoms like fatigue, dizziness, weakness, dyspnea or abdominal discomfort.

Evaluation and Assessment

- *ECG:* Usually the findings are nonspecific (Fig. 6.4). However, patients with prior MI may show pathological Q waves.
- *Stress testing:* Stress testing often detects subtle signs of CHD including angina pectroris, cardiac rhythm disorders, ECG abnormalities and an abnormal blood pressure which otherwise may remain undetected under resting conditions.
- *Coronary angiography:* This may be considered as most reliable diagnostic tool to detect the presence, extent and severity of CHD.

Management

- Balanced diet:
  - Diet rich in fruits, vegetables and whole grains
  - Limited intake of saturated fats and cholesterol
- Pharmacological management:
  - Aspirin
  - β-Blockers

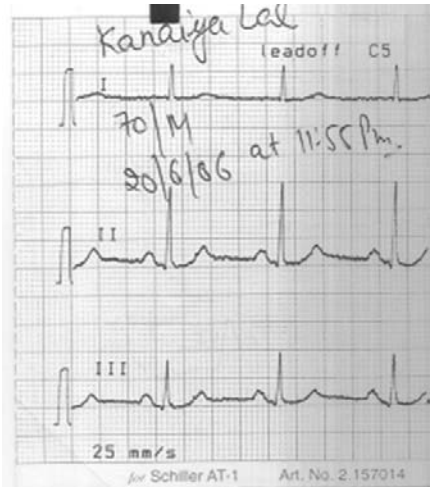

Fig. 6.4: Normal ECG

Nitrates
Calcium channel blockers
Lipid-lowering agents

- *Revascularization*
  Percutaneous coronary revascularization
  Coronary artery bypass surgery
  Both are suitable options for older patients with severe symptomatic CHD
- *Physical therapy*
  Aerobic exercise program as described in chapter IV

Arrhythmias and Conduction Disturbances

Normal rhythm originating from the SA node is called sinus rhythm. The R-R interval is regular and the rate may vary between below 60 beats/minutes and above 100 beats/minutes. The former is known as sinus bradycardia and is common in fit individuals or during rest or sleep whereas the latter is known as sinus tachycardia and is common after exercise (Fig. 6.5). However, age-related changes may disturb the sinus rhythm, and predispose elderly to arrhythmias and conduction disturbances. These age-related changes are:

– Diffuse degenerative changes in the sinus node and atrial conduction system
– A decline in the number of sinus node pacemaker cells
– An impaired conduction of the electrical impulse from the sinus node to the atrial tissues
– Delayed conduction within the atria and through the AV node.

The most common disturbances in cardiac rhythms and conductions are described here.

Fig. 6.5: Sinus tachycardia

Atrial Fibrillation (Fig. 6.6)

Atrial fibrillation occurs due to continuously discharging and contracting of multiple areas of the atrial myocardium. This sequence of depolarization and contraction is disorganized and irregular to the extent that the atria quiver rather than contracting uniformly. The ECG is diagnostic and shows fibrillatory atrial activity with an irregular ventricular response (Fig. 6.6). The ventricular rate varies between 70 and 170 beats/min whereas the atrial rate may be as fast as 400 to 1000 times the ventricular rate. This much fast atrial rate results into the absence of P waves in ECG.

Normally, contraction of atria can add as much as 30 percent to the cardiac output. However, in atrial fibrillation, the atria are not contracting well. Thus, without it, cardiac output can decrease up to 30 percent. Cardiac output is usually not affected in a patient having ventricular response of less than 100 beats/min. But, if the heart rate is more than 100 at rest or during exercise, the signs of decompensation are quickly demonstrated. There is also a danger of blood coagulation in fibrillating atria. Mural thrombi may form and subsequently lead to an embolus.

The causes of atrial fibrillation may be the cardiac disease such as cardiomyopathy, CHF, hypertensive heart disease, ischemic heart disease, pericarditis, valvular disease, cardiac surgery; and noncardiac disease such as chronic pulmonary disease, infections, pulmonary emboli, thyrotoxicosis and alcoholism. Common symptoms are palpitations and dizziness. However, if the atrial rate is not too high, patients are relatively asymptomatic. Management of atrial fibrillation includes:

- Identification and treatment of the underlying cause
- Controlling the ventricular rate:
  β-blockers, diltiazem, verapamil and digoxin slow conduction through the AV node, thus slowing the ventricular response rate
- Restoring and maintaining normal sinus rhythm
  Antiarrhythmic drugs—amiodarone is the most effective drug
  Cardioversion—either pharmacologically or electrically
- Reducing the risk of thromboembolic events
  Long-term anticoagulation with warfarin

Fig. 6.6: Atrial fibrillation

Sick Sinus Syndrome

Sick sinus syndrome occurs due to problems with both impulse generation and conduction at or above the AV node region. Patients with sick sinus syndrome may have symptoms of bradycardia, tachycardia or both. The main bradyarrhythmias include inappropriate sinus bradycardia, sinus pauses and sinus arrest; whereas atrial fibrillation, atrial flutter and atrial

tachycardia are the most common supraventricular tachyarrhythmias. A symptomatic bradyarrhythmia may require a permanent pacemaker. As many of the drugs used to treat tachyarrhythmias can worsen the AV block or SA arrest; insertion of a pacemaker is must before drug therapy is begun. In the United States, sinus node dysfunction is the most common indication for permanent pacemaker implantation and may account for approximately 50 percent of all pacemaker procedures.

Ventricular Arrhythmias

Ventricular arrhythmias are of three types:

1. *Isolated ventricular ectopic beats:* Are usually asymptomatic. The ECG demonstrates a premature and widened QRS complex that is not clearly preceded by a P wave. Most of the cases do not require specific treatment.
2. *Ventricular tachycardia:* Is the occurrence of a fast regular ventricular rate (150-250 beats/min). It may result in dizziness or syncope. The ECG reveals a wide QRS complex with duration of greater than 0.12 sec. The P or the T waves are not easily distinguishable. Also the P-R interval is not measurable. Unstable patients are treated with cardioversion and in more stable patients intravenous antiarrhythmic drugs are administered.
3. *Ventricular fibrillation:* Is the totally disorganized depolarization and contraction of the ventricular myocardium so that no coherent contractions occur and as a result there is no effective ventricular output. It is the commonest cause of cardiac arrest. The ECG findings are a fine to coarse zigzag pattern with no detectable P waves or QRS complexes and not measurable P-R interval. Blood pressure or pulse is not detectable. Cardiopulmonary resuscitation is carried out immediately while waiting for electrical defibrillation. Antiarrhythmic drugs are used as adjuncts to cardioversion.

Heart Block

A disturbance in the conduction mechanism of heart causes heart block, also called atriovenous block. Three types of heart block are there:

First degree heart block: There is a delay in AV conduction. The rate is slower than normal leading to the P-R interval of longer than 0.2 sec. common causes are acute MI, drug toxicity and myocarditis. It may be considered as a feature of normal aging. No treatment is required as it does not affect the patient much.

Second degree heart block: There is a blocked atrial conduction of varying frequency. After the dropped beat, which is seen as a P wave not followed by a QRS complex, the AV conduction returns to normal and the cycle repeats itself with either the fixed or a variable conduction ratio. If there are two P wave deflections to each ventricular deflection, it is known as 2:1 block. Thus, larger the block (3:1 or 4:1), slower is the heart rate. The ECG reveals frequent P waves with fewer QRS complexes. Cardiac pacemaker is implanted in patients having the symptoms of dizziness or syncope.

Third degree (complete) heart block: There is no atrioventricular conduction. The atrial rate may remain normal because it continues to originate from SA node whereas ventricular rate is slower than normal, i.e. approximately 33 beats/min, because of its complete dissociation from the atria. This ventricular rate is established either at the level of AV node, giving rise to a narrow QRS complex or below the level of AV node, giving rise to a wide, bizarre QRS complex. There may be the symptoms of poor cardiac output and usually the patient requires the insertion of a cardiac pacemaker.

Bundle-branch blocks

There is a disturbance in intraventricular conduction. The QRS complex is typically wide, which may be greater than 0.1 sec, otherwise the P wave, the P-R interval and the heart rate- all are normal. The cause may be a wide variety of conditions like ischemia, valvular heart problems, myocarditis and degenerative processes that causes conduction disturbances.
Exercise training in arrhythmias and cardiac disturbances (Table 6.3):

Table 6.3: Tips for a physical therapist for exercise training

– Thorough cardiac evaluation is a prerequisite for the determination of the type of arrhythmia and conduction disturbance
– Do not determine the seriousness of a condition just by taking a pulse
– Identify and understand the underlying cause of arrhythmias and conduction disturbances so that an appropriate exercise program can be planned
– Be aware of significant contraindications to exercise training
– Atrial flutter, ventricular tachycardia and ventricular fibrillation are the absolute contraindications to exercise training
– Atrial fibrillation and heart block are relative contraindications to exercise training
– Bundle-branch is no contraindication to exercise training
– In general, atrial arrhythmias without conduction disturbances are less serious than ventricular arrhythmias.

Hypertension

Definitions

- According to JNC VII (Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure VII) criteria,[1] hypertension in older adults is defined as an elevation in systolic or diastolic blood pressure.
- In elderly persons, many clinicians define hypertension as SBP >160 or DBP >90.
- In the presence of normal DBP (<90), SBP (>160) is referred to as isolated systolic hypertension (ISH).

Prevalence

- In United States, hypertension is affecting >50 percent of non-institutionalized older population.
- In India, hypertension is affecting 40 percent of urban elderly population and 18 percent of rural elderly population.

Thus, hypertension is more common in developed than developing countries or in urban than rural population. This may be due to difference in lifestyle, diet, stress and the level of physical activity. The increase in prevalence of hypertension with age can be attributable to:[2]

- Decrease in cardiovascular function: For example, decreased compliance of vascular tissue and decreased baroreceptor sensitivity.
- Decrease in renal function: For example, decreased ability to excrete water and sodium.

Classification

- Primary or essential hypertension- Most elders have no identifiable cause.
- Secondary hypertension—This is extremely uncommon in elders. The causes are renovascular problems such as bilateral atheromatous renal vascular disease, pheochromocytoma, Cushing's syndrome, obstructive sleep apnea and neurological problems, e.g. intracranial tumors. Among these, renovascular hypertension is most common.

Aggravating Factors

- Emotional stress
- Excessive alcohol intake
- Excessive salt intake
- Lack of regular exercise
- Low potassium intake
- Low calcium intake
- Nicotine
- Obesity

Pseudohypertension

Pseudohypertension is the overestimated blood pressure in the periphery. For example, blood pressure measured at brachial site may be significantly higher than the direct arterial measurement. This relatively rare phenomenon may be due to arterial rigidity from extensive atherosclerosis. The presence of pseudohypertension is indicated by Osler's sign- a palpable radial artery when the BP cuff is inflated above the SBP.

Signs and Symptoms

- Most elderly patients are asymptomatic
- Some patients may have dizziness, palpitations or headache
- End-organ damage, such as CHF, stroke or renal failure, may be the initial presentation.

Evaluation and Assessment

- Measurement of both standing and sitting BP in both arms using an appropriate cuff size after 5 min of rest. Ideally BP should be measured without the influence of alcohol, caffeine or tobacco.
- Once diagnosis is confirmed, further evaluation includes:
  - Routine laboratory tests: Complete blood count, urine analysis, electrolytes, creatinine, lipid profile, thyroid-stimulating hormone (TSH), fasting glucose and ECG
  - Assessment of cardiac risk factors: Especially smoking, dyslipidemia and diabetes mellitus
  - Assessment of end-organ damage: Angina, prior MI, CHF, carotid bruits, peripheral arterial disease, stroke, nephropathy, retinopathy
  - Thick renal artery stenosis if sudden onset of hypertension or sudden rise in BP in previously well-controlled hypertension or persistent hypertension after the administration of three antihypertensives.

Management

JNC-VI recommendations: lowering BP below 120/80 is not recommended

Non-pharmacological management:

- Adequate calcium and magnesium intake as well as low fat diet to improve general health
- Adequate dietary potassium intake. For example, fruits and vegetables
- Reduction in dietary sodium intake of 1.5 to 2.5 gm/day
- Moderation of alcohol intake- limit to 1 oz of ethanol/day
- Weight reduction if patient is obese- even a 5 kg weight loss can significantly lower BP
- Aerobic exercise- 30 min, 5 to 6 days/week
- Cessation of smoking

Pharmacological management:

- Diuretics
- Sympatholytic agents β-blockers
- ACE inhibitors
- Calcium agents channel blockers

Antihypertensive drugs commonly used in elderly patients are given in Table 6.4.

Table 6.4: Antihypertensive pharmacotherapy for elderly patients

Drug group	*Geriatric dose range, total mg/day*	*Indications in addition to hypertension*	*Mode of action*	*Side effects*
Diuretics Hydrochloro-thiazide	12.5-25	Typical first-line therapy	Diminish the volume of fluid in the vascular system	Hypokalemia, hyponatremia, hypercalcemia, hyperuricemia, mild hyperglycemia, mild hyperlipidemia
β-blockers Atenolol	25-50	CAD, systolic dysfunction	Interrupt sympathetic stimulation of the heart and peripheral vasculature	Bronchospasm, second- and third-degree heart block, fatigue, sleep disturbance;Caution with diabetics and peripheral arterial disease; low lipid solubility

Contd...

Contd...

ACE inhibitors captopril	12.5-150 2.5-10	Diabetics, CHF, LV dys-function after MI	Block the formation of angiotensin II- a potent vasoconstrictor.	Cough, rash, loss of taste, hyperkalemia
Calcium channel blockers amlodipine		Typical first-line therapy	Inhibit the entry of calcium into cardiac muscle cells and vascular smooth muscle cells, thus reducing contractility in these tissues	Flush, headache, local ankle edema

Congestive Cardiac Failure

Heart failure is a clinical syndrome that occurs when cardiac pump function is inadequate, at normal filling pressures, to meet the circulatory demands of body.[3] Congestion or retention of fluid, particularly in lungs and legs, is the major consequence of heart failure; hence, the term congestive cardiac failure is generally used.

Prevalence

CHF is one of the most common disorders of older age. There is a 4-fold increase in the prevalence of CHF between 65 and 85. The exponential increase in the rate of prevalence reflects the incapability of the aging heart to increase cardiac output in proportion with increased demands.

Causes

- Causes of systolic dysfunction are
  - Dilated cardiomyopathy
  - Pulmonary embolism
- Causes of diastolic dysfunction are
  - Hypertrophic restrictive cardiomyopathy
  - Endomyocardial fibrosis
  - Amyloidosis
- Causes of mixed dysfunction are
  - CAD
  - Hypertension
  - Diabetes

Precipitating Factors

- Anaemia
- Physical inactivity

- An increased sodium intake
- Excessive environmental heat or humidity
- Emotional stress
- Physical overexertion
- Thyrotoxicosis
- Renal insufficiency
- Infection, inflammatory or immunological processes, that can have a direct effect on the myocardium.

Signs and Symptoms

- General signs of CHF include
  Tachypnea
  Central cyanosis
  Peripheral cyanosis
  Hypotension
  Sinus tachycardia
- Right-sided heart failure
  Edema, particularly in the dependent body parts, is the classic sign
- Left-sided heart failure
  Exertional dyspnea - is usually the first sign
  Dyspnea even when lying flat – develops afterwards
- Nonspecific symptoms
  Fatigue
  Muscle weakness
  Anorexia
  Nausea
  Difficulty with memory and concentration
  Headache

Evaluation and Assessment

- An echocardiogram to evaluate left ventricular function in initial stage of CHF.
  – Systolic dysfunction—If an ejection fraction (EF) < 40 percent
  – Diastolic dysfunction—If an ejection fraction (EF) ≥ 40 percent
- Routine tests include ECG, TSH, CBC, electrolytes, creatinine, albumin
- Chest radiography to demonstrate cardiomegaly, pleural effusion, and signs of pulmonary venous congestion as well as alveolar edema.

Management

- *Treatment of underlying cause*
  For example, antihypertensives in case of hypertension, antiarrhythmics in case of arrhythmias
- *Pharmacologic management*
  The outlines of management are given in Table 6.5.

- *Nonpharmacologic management*
  Measurement of body weight: Should be done daily
  Exercise at moderate intensity: If there are no symptoms of CHF at rest
  Salt restriction: 3 gm sodium diet is desirable in mild to moderate cases of CHF

Table 6.5: Pharmacologic management

Drug therapy	*Indications*
Diuretics • Thiazide diuretics, e.g. Hydrochlorothiazide • Loop diuretics, e.g. bumetanide	Increase salt and water excretion by the kidney
Positive inotropic drugs • Cardiac glycosides, e.g. digoxin • Sympathomimetics, e.g. dobutamine • Phosphodiesterase inhibitors, e.g. enoximone	Enhance the contractility of heart
Vasodilators • ACE inhibitors, e.g. captopril • Directly acting vasodilators, e.g. hydralazine	Reduce the workload of the heart by reducing arterial resistance

RESPIRATORY DISORDERS IN ELDERLY

Chronic Obstructive Pulmonary Disease

COPD is a spectrum of chronic respiratory diseases characterized by limitation of expiratory airflow. Airflow limitation is mostly due to fixed airway obstruction, which is usually progressive in nature. Chronic bronchitis and emphysema are included in COPD.

Prevalence

The prevalence of COPD increases in the sixth decade, affecting equal numbers of men and women. It is a major cause of disability and death in most countries and contributes significantly to escalating healthcare costs.[5]

Risk Factors

- Smoking, especially of cigarettes
- Air pollution
- Occupational exposure to organic or inorganic dusts and to noxious gases
- Genetic risk factor namely α1-antiprotease deficiency.

Signs and Symptoms

- Airflow limitation
- Cough
- Dyspnea
- Frequent pulmonary infection
- Impaired gas exchange
- Sputum production.

Evaluation and Assessment

- Spirometry confirms the diagnosis
- An FEV_1 to FVC ratio < 70 percent and postbronchodilator FEV_1< 80 percent of predicted value for age, weight and height, indicate airflow obstruction
- FEV_1 falls below 50 percent of the predicted value in patients with exertional dyspnea.
- Dyspnea at rest occurs when FEV_1= 25 percent of the predicted value. At this time there may be presence of carbon dioxide retention and Cor pulmonale (enlargement of right ventricle)
- Testing for lung volumes may display hyperinflation with increased total lung capacity and residual volume.

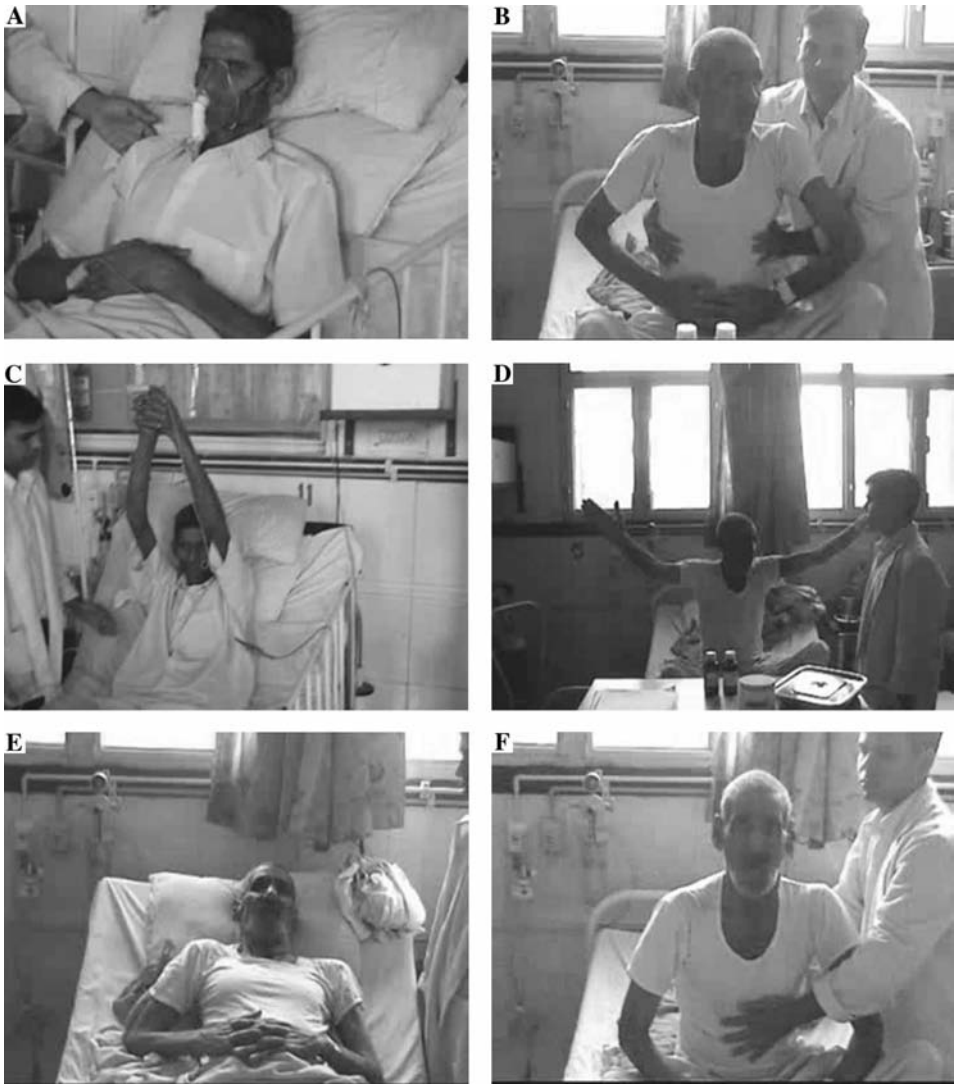

Fig. 6.7: Active cycle of breathing techniques

Mortality

Mortality rate is very high. Only about 20 to 30 percent of patients with severe obstruction and carbon dioxide retention survive beyond 5 years.

Management

- *The goals of management are to get symptom control, preserve lung function and ultimately improve quality of life.*
- *Smoking cessation is essential*
- *Pharmacologic management*
  - The pharmacologic management of COPD does not alter the progressive decline in lung function. Also, it does not affect the mortality rate.
  - A typical treatment approach is a stepped approach as displayed in Table 6.6. It involves progressive addition of medications in order to gain maximum symptomatic control.
  - Continuous oxygen therapy is advised to hypoxemic patients.
  - Antibiotic therapy is indicated when there is a possibility of infection.
- *Physical therapy:*
  - **Humidification to allow the functions of the respiratory tract to take place smoothly.** The patients of COPD often have copious thick secretions. So, it is the duty of a physiotherapist to ensure that the patient is optimally humidified. A heated water bath has less irritant effect on sensitive airways and is helpful in removing the secretions.
  - **Chest physiotherapy to manage secretions:** Conventional technique of postural drainage may not be suitable for elderly patients, partly because of the feeling of discomfort due to the postures used in the technique or fear out of the blows of chest manipulations used in the technique. Moreover, there is a risk of a pathological fracture of osteoporotic ribs. The active cycle of breathing techniques and autogenic drainage are the alternative techniques to be used in the patients of COPD to mobilize and aid the expectoration of secretions:[9, 10]

1. *Active cycle of breathing techniques:* The active cycle of breathing techniques is a cycle of breathing control, thoracic expansion exercises and the forced expiration technique. (Fig. 6.7)
   - **(i) Breathing control:** Patient is asked to breathe at his/her own comfortable rate, using the lower chest with the chest and shoulders relaxed. This technique is used between the more active components of a cycle, as it allows the patient to take rest after the exertion of coughing.
   - **(ii) Thoracic expansion exercises:** This is a deep breathing technique that emphasizes inspiration. Patient is asked to take in some deep breaths followed by quiet, unforced expiration. During these thoracic expansion exercises, the lung volume is increased, which in turn, facilitates collateral ventilation and allows air to flow behind bronchial secretions. Thus, helps in mobilizing the secretions up the bronchial tree.
   - **(iii) Forced expiration technique:** Patient is asked to do one or two forced expirations, also known as huffs, from mid to low lung volume. This technique assists to loosen and clear peripheral secretions. It is always better to combine forced expiration technique with breathing control to avoid any possibility of air flow obstruction. It can be used even for the hypoxemic patients.

2. *Autogenic drainage:* Patient's cooperation and understanding is very important for the correct execution of this technique. The patient is asked to adjust the rate, location and depth of breathing. This kind of controlled breathing may help to achieve the best possible air flow throughout the bronchi and thus, assists the clearance of secretions.
   - **Respiratory muscle training to improve the strength and coordination of respiratory muscles as well as to reduce the respiratory frequency:** Physical therapist should direct the patient to perform breathing exercises in a posture that helps to reduce the "load" on respiratory system. Use of respiratory exerciser will provide biofeedback to a patient and thus, encourage improving the work of respiratory muscles (Fig. 6.8).

Fig. 6.8: Patient is using respirator exerciser

   - *Aerobic exercise to improve energy level:* Many studies have demonstrated that patients with COPD can participate in erobic exercise training program to improve pulmonary functional capacity.[7,8] This, in turn, helps to reduce breathlessness and a sense of exertion during work and thus,improves the quality of life.
   - *Strengthening exercise to improve the efficiency of peripheral musculature:* This specific muscle training is particularly important for the patients who can not participate in erobic exercise due to psychological fear or too much breathlessness.
   - *Upper extremity exercise training to improve endurance and strength during arm activities:* Patients with COPD often feel breathlessness while performing upper limb activites. This may be due to hyperinflation of chest and consequent mechanical disadvantage to shoulder girdle of these patients. Hence, upper extremity exercise training must be included in physical therapy program.
   - The most important benefit of physical therapy is that the level of perceived dypnea goes down, as there is an improvement in patient's exercise tolerance.
   - Another benefit is a reduction in the effects of osteoporosis, which could be a result of long-term corticosteroid use.
   - Precautions while administering physical therapy program (Table 6.7):

- **Surgery:** Lung transplantation and lung volume reduction in highly selected patients ≤ 65 years.

Table 6.6: A stepped approach in pharmacologic management of COPD

Step	*Clinical symptoms*	*Treatment*
I	Mild and intermittent symptoms	β-agonist every 2 to 6 hr
II	Mild to moderate regular or daily symptoms	Scheduled ipratropium bromide plus β-agonist every 2 to 6 hr
III	If unsatisfactory response to step II	Add theophylline and/or albuterol and/or mucokinetic agent
IV	If unsatisfactory response to step III	Oral steroids

Table 6.7: Precautions while administering physical therapy program

- Remember that conventional hands-on approach with percussion-like chest manipulation is not easily tolerable by the elderly patients, particularly in the presence of osteoporosis.
- Monitor the level of patient's oxygen saturation during exercise.
- Adjust the level of supplemental oxygen during exercise.
- Update the exercise program periodically based on the progression of the disease and patient' exercise tolerance.

Asthma

Asthma is a chronic inflammatory disease of the airway.

Prevalence

The prevalence of asthma is 6 to 8 percent after the 6th decade of life. This lower rate of prevalence in elderly may be attributable, in part, to underdiagnosed cases of asthma in older years. The factors responsible for underdiagnosis are:

- Presence of breathlessness to normal aging or to the disorders like cardiovascular disorders
- Blunt perception of bronchoconstriction in elderly
- Less severe symptoms than younger asthmatics with the similar degrees of airflow obstruction

Risk Factors

- Air pollution
- Smoking
- Allergens
- Exercise
- Infectious agents such as viruses
- Chemicals
- Emotional distress
- A genetic predisposition, primarily in the form of atopy

Signs and Symptoms

The characteristic symptoms of asthma is the presence of recurrent episodes of

- Cough
- Chest tightness
- Shortness of breath
- Wheezing

  However, it is difficult to classify these symptoms in elderly. Moreover, it is less variable and episodic than in the younger individuals.

Evaluation and Assessment

- Most important diagnostic clue is the airflow obstruction which is reversible after the inhalation of bronchodilator.
- Spirometry assesses the severity of airflow obstruction.
- An FEV_1 to FVC ratio < 0.70 indicates airflow obstruction.

Mortality

Asthma leads to increased hospitalization and decreased quality of life. Mortality rate is higher in elderly than the younger patients.

Management

- *Pharmacologic management (Table 6.8):*
  - Stepped approach, depending upon the severity of symptoms, is followed.
  - Two main types of drugs are classified as "relievers" and "preventers" used for short – term and long-term control, respectively.
  - Severe exacerbation of asthma is treated in hospital with aerosolized β_2-agonist and high concentrations of oxygen, under continuous ECG monitoring.
- *Nonpharmacologic management:*
  - Avoid allergens
  - Stop smoking
  - Encourage the patient to take responsibility for day-to-day treatment
- *Physiotherapy:*
  - Teach the patient different kinds of positioning which aims to reduce the work of breathing during an acute exacerbation of asthma.
  - Manual techniques should be avoided when there is acute bronchospasm.
  - Breathing exercises should be done regularly during the silence period, i.e., when there is no acute exacerbations of asthma.

Table 6.8: Stepped approach in asthma

Step	*Severity*	*Relievers*	*Preventers*
I	Mild, intermittent	Short-acting inhaled β_2-agonist	Inhaled steroids in low dose or cromolyn
II	Moderate	Short-acting inhaled β_2-agonist, as needed but not to exceed 3-4/d	Inhaled steroids in low to moderate dose and long-acting inhaled β_2-agonist
III	Severe, persistent	Short-acting inhaled β_2-agonist, as needed but not to exceed 3-4/d	Inhaled steroids in high dose and long-acting inhaled β_2-agonist or theophylline

Pulmonary Embolism

Pulmonary embolism is an impacted thrombus in the pulmonary arterial circulation, after being dislodged from a systemic vein. Over 90 percent of pulmonary emboli are thrown off from thrombi in the deep veins of the lower extremities and pelvis. A few may arise in the right atrium when a clot forms in association with atrial fibrillation or from a mural thrombus in a damaged area of the right ventricle following myocardial infarction.[6]

Risk Factors

- Age: The risk approximately doubles for every decade beyond age 40
- Bed rest
- Prior venous thromboembolic disease
- Obesity
- Malignancy
- Immobilization
- Major sugery
- Fracture of lower extremity bone
- Long journeys
- Congestive cardiac failure
- Paralytic stroke
- Genetic factors such as antithrombin deficiency.

Signs and Symptoms

- Classic triad-dyspnea, chest pain, hemoptysis-occurs in ≤ 20 percent of cases.
- Syncope indicates extensive occlusion of pulmonary vascular bed or an arrhythmia with low cardiac output.
- Hypotension is the hallmark of massive pulmonary embolism.

Evaluation and Assessment

- Pulmonary angiography is most accurate
- Spiral-chest CT scan is accurate for identifying a clot in the main, lobar and segmental pulmonary arteries but not in subsegmental arteries.
- Ventilation/perfusion scanning is often used, as it is noninvasive and generally available. However, it is rarely diagnostic. Hence, it should be combined with an estimate of clinical suspicion.

Mortality

Mortality rate in promptly diagnosed and appropriately treated cases of pulmonary embolism is < 4 percent. However, it is considerably higher in untreated cases.

Management

- Standard therapy for pulmonary embolism is a continuous intravenous infusion of unfractionated heparin followed by warfarin
- Acute massive pulmonary embolism should be treated with thrombolytic therapy within 48 hrs of onset:
  - Streptokinase, urokinase and alteplase are the commonly used thrombolytic drugs.
  - Surgical embolectomy and catheter-directed clot extraction or clot fragmentation are other options.

Prophylaxis

Prophylactic measures should be considered for all patients who are at risk of developing deep vein thrombosis and subsequently pulmonary embolism:

- Early ambulation in patients at low risk: minor surgery, age < 40 years
- Prompt mobilization, heparin, elastic stockings or intermittent pneumatic compression device in patients at moderate to high risk: major surgery, age >60 years.

To Summarize

Elderly patients suffering from cardiorespiratory disorders do benefit from the expertise of physical therapist. The goal of therapeutic intervention is to attain maximum functional independence within weeks to months and within the limits of cardiorespiratory and other pathologies.

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7 Musculoskeletal Disorders in Elderly

- **Osteoporosis**
- **Osteoarthritis**
- **Rheumatoid Arthritis**
- **Gout Arthritis**

OSTEOPOROSIS

Osteoporosis is one of the most common disorders to be found in elderly populations. The literal meaning of osteoporosis is "porous bones". This bone-weakening disorder has long been neglected in India. But now, with growing awareness, it is fast emerging as a public health problem of major concern among Indian populations.

Definition

- Osteoporosis is a skeletal disorder characterized by compromised bone strength (bone density and bone quality) predisposing to an increased risk of fracture.[1]
- Definition based on World Health Organization criteria (Table 7.1):

Table 7.1: Classification of skeletal status based on World Health Organization criteria

Category	Definition by bone mineral density (BMD)
Normal	BMD that is not >1 SD below the young adult mean value
Osteopenia	BMD that lies between 1 and 2.5 SD below the young adult mean value
Osteoporosis	BMD that is not >2.5 SD below the young adult mean value
Severe osteoporosis	BMD >2.5 SD or below the young adult mean value in the presence of one or more fragility fractures.

Prevalence

According to National Osteoporosis Foundation, in the United States in 2002, 32 million women and 12 million men older than 50 have either osteoporosis or low bone mass. This number is

expected to increase to 52 million by 2010. The prevalence of osteoporosis increases with age from 15 percent in women 50-59 years old to 70 percent in women 80 years old. The lifetime risk for fracture in 50-year-old woman is 40-50 percent.[2] The relationship of bone mass to muscle mass[3] and fracture risk[4] is, as such, similar in older men and women, but due to the greater number of older women and their lower bone and muscle mass and strength, osteoporosis appears as a major female health problem.

Impact on Economical Status

In the UK alone osteoporotic fractures affect over 200,000 individuals annually, with treatment costs of about £1.4 billion[15] whereas in US the estimated cost of osteoporotic fractures is about $13.8 billion per annum.[5] Thus, the treatment cost of osteoporotic fractures is significant and it is projected that by the year 2020, it will rise up to $30-60 billion annually.[6]

Pathophysiology

Bone constitutes a dynamic connective tissue which provides the mechanical integrity for locomotion and protection; is involved in the metabolic maintenance of mineral homeostasis; and serves as the primary site of hematopoiesis. The mineral and organic matrix structure of bone tissue as well as the shape and geometry of different bones provide the skeleton with excellent mechanical strength while at the same time being lightweight and adaptable. To fulfil these structure/function relationships, bone is constantly being broken down and rebuilt in processes of bone modelling and remodelling.[7] With aging, however, remodelling tends to remain uncoupled in the pockets of bone which has been removed during resorption. Thus, in older individuals, the rate of resorption exceeds the rate of remodelling resulting in a net loss of bone or osteoporosis. Fig. 7.1 indicates that peak bone mass is usually attained by the age of 30 years, thereafter a decline in bone mass and structural integrity starts and becomes evident around 50 years of age.

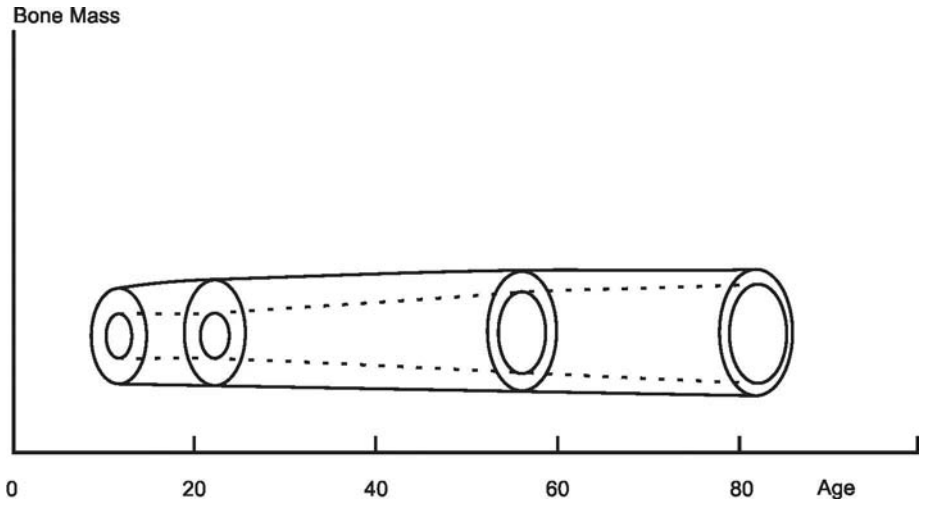

Fig. 7.1: Age-related changes in bone mass and structural integrity

Risk Factors

- *Genetic factors*
  - White/Asian > blacks
  - Family history
  - BMI < 19
- *Lifestyle factors*
  - Poor physical function
  - Low muscle strength
  - Alcohol abuse
  - Smoking
  - Highly trained athletes
  - Lack of exposure to sunlight
- *Drugs*
  - Corticosteroids
  - Sedatives
  - Anticonvulsants
  - Heparin
  - Lithium
- *Nutritional factors*
  - Low calcium intake
  - Poor nutrition
- *Endocrine disorders*
  - Thyrotoxicosis
  - Hyperparathyroidism
- *Inflammatory disorders*
  - Ankylosing Spondylitis
  - Rheumatoid Arthritis
- *GIT disorders*
  - Malabsorption
  - Chronic liver disease
- *Women at risk*
  - Early menopause
  - Amenorrhoea
  - Estrogen deficiency
- *Men at risk*
  - Androgen deficiency
- *Others*
  - History of fracture
  - Recurrent falls
  - Frailty
  - Decreased cognition
  - High rates of dementia
  - Depression

Signs and Symptoms

- No signs and symptoms until there is a fracture.
- A fracture is considered to be osteoporotic, if it is due to relatively low trauma, e.g. a fall from standing height or a force that is usually not expected to cause a fracture in a young healthy adult.
- Common sites are vertebral spine and hip.
- Other sites are wrist, pelvic, proximal humerus and distal shaft of femur.
- About 66 percent of vertebral fractures are asymptomatic and may be diagnosed during routine examination, particularly chest or abdominal X-ray examination.
- The most common sites for vertebral fractures are lower thoracic and upper lumbar spine.
- Vertebral osteoporotic fractures can lead to back pain and thoracic kyphosis.
- Back pain may be of acute onset, typically occurring during daily activities such as lifting weight or bending forward. This acute pain may be either a chronic dull ache or is resolved during the course of prolonged time period.
- Increasing thoracic kyphosis may cause height loss, development of "dowager's hump", crowding of internal organs, forward neck posture giving rise to neck pain; and dyspnea and gastrointestinal symptoms due to decreased distance between the bottom of the rib cage and the top of the iliac crests.
- Hip fractures are more common in osteoporosis. The patients complain of having difficulty in standing and inability to walk. The leg remains in external rotation and shorter than contralateral side.
- In case of impacted hip fracture, patient may occasionally be able to walk.
- Intertrochanteric hip fractures are more unstable with substantial blood loss and hemodynamic compromise.
- The wrist osteoporotic fracture is associated with continuing pain and impaired function of hand.

Evaluation and Assessment

- *Laboratory evaluation*
  - *Laboratory tests to exclude secondary cause of osteoporosis*: For example, assessment of thyroid function to exclude hyperthyroidism; serum testosterone to exclude hypogonadism in men; other serum chemistries to evaluate hepatic and renal function; and complete blood count and ESR for the assessment of multiple myeloma.
  - *Biochemical markers of bone turnover*: Two types of biochemical markers of bone turnover are available and can be considered as adjunctive to BMD:
    I. *The markers of bone formation*: Serum alkaline phosphatase, osteocalcin, serum procollagen type I carboxyterminal propeptide (P1CP) and serum procollagen type I N-terminal propeptide (P1NP) – all can be used to measure osteoblastic activity. P1CP and P1NP are the newer markers of collagen formation, low levels of which indicate that little collagen is being made.
    II. *The markers of bone resorption*: Osteoclastic activity can be identified by measuring hydroxyproline, deoxypyridinoline, collagen type I corss-linked N-telopeptide and collagen type I corss-linked C-telopeptide in urine.

- *BMD test*: BMD test is used to establish the diagnosis of osteoporosis, to assess the risk of osteoporotic fracture, to identify candidates for therapeutic intervention and to assess the effects of treatment on bone loss. Table 7.2 describes the different techniques of BMD.

Table 7.2: Different techniques of BMD

Technique	*Sites measured*	*Remarks*
Dual energy X-ray absorptiometry (DEXA)	Central and peripheral	Most common but expensive Precise measurements Minimal radiation
Quantitative computed tomography (QCT)	Central and peripheral	Specifically measures trabecular bonenot influenced by degenerative disease Poor precision High cost High radiation dose
Quantitative ultrasonometry (QUS)	Peripheral	Portable Low cost No radiation Lack of precision Not useful in monitoring
Radiographic absorptiometry (RA)	Peripheral	Uses conventional X-ray machine Measures bone density in a largely cortical site

Mortality

Hip osteoporotic fractures are associated with an increased mortality whereas vertebral and wrist fractures with significant morbidity. In the United States, the 1-year mortality rate is from 12 percent to 20 percent in those who sustain a hip fracture.[6]

Prevention

In 1990, there were an estimated 1.65 million hip fractures worldwide, which is projected to increase up to 6.3 million by the year 2050.[2] These numbers highlight the need for effective prevention strategies. Some of these strategies are described here:

- *Prevention strategy to maximize peak bone mass*: Adequate calcium and vitamin D intake in addition to appropriate exercise, during growing age, helps to achieve peak bone mass.
- *Prevention strategy to reduce postmenopausal bone loss*: In the first 5 years of postmenopausal period, the rate of decline in bone density is about 2 percent per year. Hormone replacement therapy (HRT) at the time of menopause can slow down this bone loss to the rate of 0.5 percent per year. However, its potential benefits versus potential risks should be considered in detail. In general, women with BMD > 1 SD below the young adult mean value may be benefited most from HRT. Alendronate and raloxifene are other pharmaceutical agents that can effectively reduce the bone loss at the time of menopause.[8, 9]
- *Prevention strategy to reduce age-related bone loss*: Following the postmenopausal period, there is 1 percent decline in bone density every year. This bone loss can be reduced by optimizing calcium and vitamin D intake.

Universal Recommendations for the Effective Prevention and Management of Osteoporosis

- Calcium intake - 1200 mg/d
- Vitamin D intake - 400-800 IU
- Aerobic exercise in combination with strengthening exercise
- No more than moderate alcohol use
- No smoking
- Falls prevention

Management

- *Pharmacological management*: Currently no drug is available which can return the bone loss to normal. However, the reports of several studies suggest that these drugs can increase the bone mass, prevent further bone loss and reduce the risk of fracture in osteoporotic bones. Table 7.3 describes the most commonly used drugs for the management of osteoporosis.

Table 7.3: Pharmacological management of osteoporosis

Drugs	*Recommended dose*	*Efficacy*	*Potential risks*
Estrogen	A transdermal patch containing 25 mcg	Increase in BMD at the spine and hip Reduce the risk of hip and wrist fractures	Breast cancer Deep vein thrombosis Increased vaginal bleeding
Raloxifene	60 mg/d	Reduce the new incidence of vertebral fracture	Deep vein thrombosis Hot flushes
Alendronate	10 mg/d or 70 mg/wk	Well tolerated Significant gains in BMD at the spine and hip reduce the risk of all nonspinal fractures	Esophagitis
Calcitonin (nasal)	200 IU/d	Reduce the new incidence of vertebral fracture	Rhinitis

- *Physical therapy*: Physical therapy has an enormous importance in the treatment of osteoporosis in the elderly. Table 7.4 displays various techniques of physical therapy with their potential benefits. It may be emphasized that the effects of exercise and HRT on bones and muscles are similar.[10] In addition, erobic exercise combined with strengthening exercise improves balance and reduce risk of falls as well as the severity of fall injuries.[11] Although, direct experimental evidence on the specific effects of strength training on fracture risk is still lacking, the exercise training may be the best single means of simultaneously modifying the key risk factors for osteoporotic fractures. Thus, an appropriate physical therapy program has a potential to improve functional ability and quality of life in patients with osteoporotic osteoporosis.

Table 7.4: Physical therapy intervention in osteoporosis

Therapeutic intervention	*Potential benefit*	*Indications*
Heat and cold therapy	Relieves acute or chronic pain associated with osteoporotic fracture	Neck pain and back pain in vertebral fracture
TENS or IFT		Forearm pain in wrist fracture
Orthoses	To provide support	Vertebral fracture
	To remove leg length discrepancy	Hip fracture
ROM and stretching exercise (specifically tailored program)	To reduce the harmful effects of inactivity on bone mass	Patients on strict bed rest
Walking 1 to 3 miles per day	Impact of weight-bearing exercise maintains and improves bone health	All capable elderly
Conditioning program:	Improve muscle mass	All elderly can participate.
1.Strengthening exercise	Increase BMD	However, the exercise program
2. Aerobic exercise	Improve bone cross-sectional geometry and mass distribution	should be in accordance with the physiological capacities of the older individual.
	Improve balance and thereby reduce the risk of falls	
	Thus, Modify the key risk factors for osteoporotic fracture	

OSTEOARTHRITIS

Osteoarthritis has the distinction of being the oldest and most prevalent chronic joint disease known to humanity. It appears to have been a constant companion of people throughout antiquity. Indeed, it even seems to have affected other animals before humans and their ancestors ever appeared. For example, osteophytes and spinal ankylosis have been found in the skeletons of dinosaurs.[12-14]

Definition

Pathologically osteoarthritis (OA) may be defined as a condition of synovial joints characterized by focal loss of articular hyaline cartilage and simultaneous proliferation of new bone with remodelling of joint contour.[15] Inflammatory changes in the synovium are usually minor and secondary.

Prevalence

About 5.7 percent of the population of India has osteoarthritis. Autopsy evidence of OA can be found in most adults older than 65 and physical examination reveals OA of the hands in 70 percent of people older than 70.[16] In general, prevalence of osteoarthritis increases with age. But at the same time younger individuals are not immune as 23 percent cases were between 40 to 50 years, 25 percent patients were found to be in the age group of 50 to 60 years and 52 percent patients were older than 60 years in a study done on Indian population by the author in 2002. Somewhat similar figures were obtained in the statistics performed in United States: between ages of 45 to 64 years, the prevalence was 30 percent and for ages older than 65 years it was 68 percent.[17]

Any joint may be affected, but the relatively lightly stressed joints of upper limb are, in general, less prone to osteoarthritis than the highly stressed joints of lower limb.[18] Knee OA is more prevalent than the hip OA, but taken together they affect 10 to 25 percent of those aged over 65 years. In Indian society the patients are very much concerned about the knee pain because kneeling and squatting position is very important for attending day-to-day and religious activities.[19]

Etiology

The cause is a disproportion between joint stress and stability of the individual joint components. In the course of this disease, healthy joint components are destroyed and replaced with inferior tissue (Fig. 7.2).

A. The healthy cartilaginous tissue featuring cartilage cells in the middle of the intercellular substance. The collagenous fibers are not visible.
B. *Stage-1*: The collagenous fibers become visible as a consequence of damage to the cartilage or with advancing age.
C. *Stage-2*: Breakage of the collagenous fibers, disintegration of the cartilage present and proliferation of the remaining cartilage cells.
D. *Stage-3*: The destroyed cartilage is replaced in some locations with a bone plate. There is formation of small bone cavities by virtue of the increased pressure with new formation of cartilage and bone on the margin of the joint resulting in bone accretion.
E. *Stage-4*: the cartilage is fully destroyed.

Factors

Aging is indeed strongly associated with osteoarthritis. However, the occurrence of the disease in young and middle-aged people strongly indicates that nearly always some factor is present

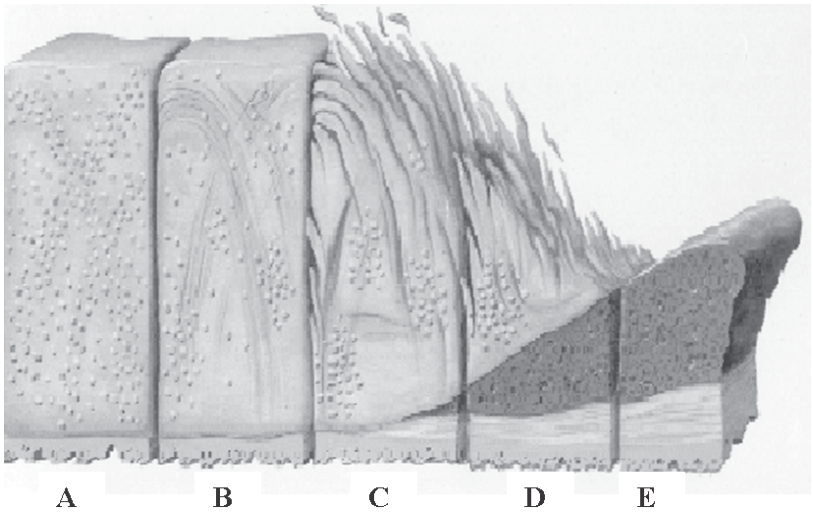

Fig. 7.2: Microscopic alteration in the presence of osteoarthritis

that has caused the joint to wear out sooner than usual.[20] In fact there is very little change in articular cartilage during the human life span under normal conditions. Thus, it becomes important to recognize the initial factors responsible for the onset of osteoarthritis.

- Obesity
- Female
- Congenital deformity
- Irregularity of joint surfaces from previous fracture or a disease
- Malalignment of a joint from any cause
- Heredity, although the responsible genes have yet to be identified
- More subtle repetitive adverse loading of joints during occupation or competitive sports: for example, farming, professional football and clerical job predispose OA of hip, knee and spine, respectively.

Clinical Features

- *Gradual onset*: It is often seen that clinical presentation may not be apparent for many years after the abnormal factors pertain and thus there can be a long interval during which the changes take place.
- Characteristics of pain:
  - Pain that increases almost imperceptibly over months and years
  - In the early stage, pain is worsened by the activity and relieved by rest
  - In the later stage, pain may be present even at rest.

These characteristics can be explained on the basis that although cartilage degeneration is the primary manifestation of osteoarthritis, cartilage is aneural, and therefore not the cause of pain. Pain in osteoarthritis may be attributed to incongruent articulations of joint surfaces, periosteal elevation secondary to bone proliferation at the joint margin, abnormal pressures on subchondral bone, trabecular microfractures, and distension of joint capsule. Many patients will also experience a secondary synovitis, especially when the knee is involved.[21] In addition to the inflammatory response, neuropeptides and peripheral opioid receptors contribute to the sensation of pain:

- In the spine, osteophyte may encroach on emerging nerve roots, causing radiating pain: for example, in case of cervical spondylosis, neck pain often radiates to shoulder, occiput, frontal region, between scapulae and down to one or both arms.
- Movements slowly become more and more restricted
- Stiffness, usually occurring in the morning and following periods of rest, is relieved by movement. One possible explanation is that the tissues surrounding the joint become water-logged during periods of inactivity. During rest, fluid leaks out of blood vessels into the joint tissues, making them feel stiff until joint movements begin to pump the fluid out of the tissues and back into blood vessels and lymph channels.[22]
- Paraesthesiae in the form of tingling or "pins and needles" in OA spine.
- Feeling of dizziness on sudden change of posture in OA of cervical spine.
- *Disability*: One of the worst things about osteoarthritis is its negative effect on quality of life. Patients with osteoarthritis, particularly of weight bearing joints are less active and tend to be less fit with regard to musculoskeletal and cardiovascular status than normal controls.[23-27] This reduces functional capacity of a patient and results into disability.

Evaluation and Assessment

- *Physical examination*
  - Joint-line or periarticular tenderness
  - Restriction of joint movements
  - Crepitus, a clicking or crackling sound, may occur as the joint is moved.
  - Atrophy and weakness of periarticular muscles
  - *Enlargement*: Joints may enlarge due to synovitis, joint effusion, connective tissue overgrowth or osteophyte formation.
  - Gait deviation, for example, waddling gait in OA knee
  - Deformity: For example, *genu varum* or flexion deformity is the most common deformity in patients of osteoarthritis knee.[18,28]
  - Heberden's nodes in OA hand
- *Radiographic examination*
  - Reduced joint space
  - Subchondral sclerosis
  - Osteophyte formation.
- *MRI*: Can detect early loss of articular cartilage. However, it is seldom needed to diagnose OA. In addition, it is more costly than conventional radiographs.

Management

Fig. 7.2 displays the real life consequences of osteoarthritis that need to be given adequate attention in the conventional physiotherapy management.

- *Pharmacological management*:
  - *Topical analgesics*: Liniment, capsaicin cream
  - *Initial drug treatment of choice*: Acetaminophen not to exceed 4 g/d
  - *Nonsteroidal anti-inflammatory drugs (NSAIDs)*: If the symptoms are not controlled, NSAIDs such as tramadol, narcotics or glucosamine can be considered. However, it should be remembered that NSAID gastropathy and gastrointestinal bleeding increases with advancing age.
- *Joint protection and energy-conservation techniques*:
  - Weight reduction, if obese
  - Ergonomic advice to reduce occupational stress, for example stretching exercises in addition to adjustment in the height of a sitting chair or a working bench.
  - Avoiding floor activities or forward bent postures
  - Shock-absorbing footwear
  - Use of walking aids, splints or braces.
- *Physical therapy*:
  - *Pain relieving modalities*:
    - Suitable electrotherapeutic modality, for example, microwave diathermy for knee pain, moist heat therapy for neck pain, shortwave diathermy for back pain and ultrasound for pain in a unilateral compartment of knee joint.
    - Hydrotherapy is indicated to relieve pain in weight-bearing joints.
    - Mechanical or manual joint distraction to relieve the compressive forces on the joint.
    - Relaxed passive movement maybe performed by a physical therapist or on CPM.

– *Exercise program*: Traditionally physiotherapists are eager to treat signs and symptoms of affected joint and often pay little attention to evaluating the needs and status of the person as a whole. Because of this limited perspective more encompassing strategies such as increasing physical activity are often overlooked. Rather it has repeatedly been reported that dynamic exercises increase disease activity and are harmful for joint structures.[29-32] Thus exercise, in particular aerobic exercise, is not emphasized enough in traditional physical therapy program of osteoarthritis. However, there are several researchers who have investigated the effectiveness and safety of physical activity to improve fitness and decrease disability in patients of OA.[33-35] An individually designed exercise program consisted of following four components should be implemented. Fig. 7.3 explains the efficacy of exercise program in treating as well as delaying the further progression of osteoarthritis:
  1. *Range of motion (ROM) and stretching exercises*: This should include appropriate weight-bearing and nonweight-bearing ROM exercises. Stretching exercise should incorporate a low load for prolonged time at a frequency of 3 to 4 times/day.
  2. *Strengthening exercises*: Low load-high repetition is the principle of strengthening the muscles in order to reduce stress on the ostearthritic joint.
  3. *Mobilization exercises*: Considering the patient's age and skeletal status, an appropriate mobilization exercises such as gliding or distraction should be used.

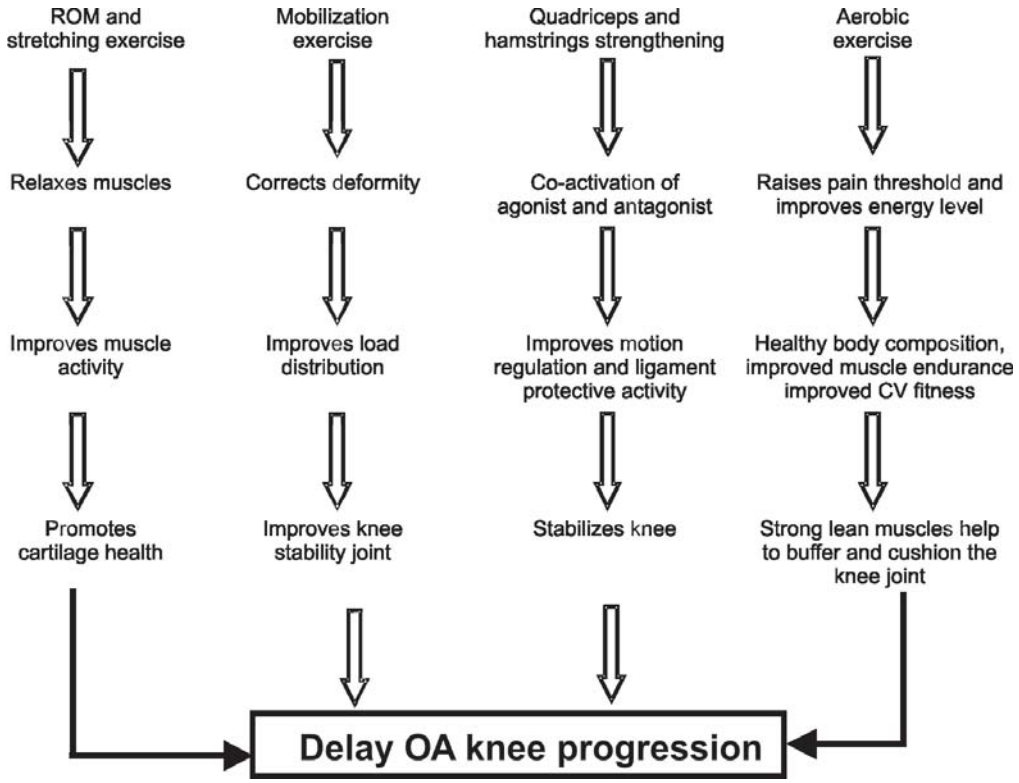

Fig. 7.3: The efficacy of exercise program in treating as well as delaying the further progression of osteoarthritis

4. *Aerobic exercises*: Aerobic exercise like swimming or cycling can be used while progressively increasing the intensity of exercise.

- *Surgery*
  - Debridement in early stage
  - Osteotomy (femoral or high tibial) is performed if there is OA in a unilateral compartment (medial or lateral) of knee joint. It helps to relieve painin majority of patients with genu varus or less commonly valgus deformity.
  - Prosthetic joint replacement in later stage, usually for hip, knee and shoulder
  - Arthrodesis is usually preferred for the wrist, ankle and first MTP joint

RHEUMATOID ARTHRITIS

Rheumatoid Arthritis (RA) is the commonest form of chronic nonbacterial inflammatory joint disease. In its typical form RA is a symmetrical, destructive and deforming polyarthritis affecting small and large synovial joints with associated systemic disturbance, a variety of extra-articular features and the presence of circulating antiglobulin antibodies.[37] Characteristically the course of the disease is prolonged with exacerbations and remissions. However, when RA has its onset after the age of 60; it starts acutely and is often of atypical form of the disease.

Prevalence and Epidemiology

- Rheumatoid arthritis occurs throughout the world.
- Climate, altitude and geography do not appear to influence its prevalence.
- A higher proportion of patients is seen in western countries and urban communities.
- The disease starts most commonly between the third and fifth decades.
- New-onset RA can be seen in older adults.[16]
- Women are affected more than men in a ratio of 3:1. However, female predominance is less marked when onset occurs beyond age 60.[36]
- Environmental conditions precipitate disease in genetically predisposed individuals.

Etiology

The cause is unknown. At present only two possibilities attract serious consideration:

1. The hypothesis of autoimmunity: It is based on the observation that the serum of many patients with RA contains an antibody known as Rheumatoid factor that reacts with body protein gamma globulin.
2. The hypothesis of infection: There is no evidence to support this hypothesis.

Pathology

Pathological changes progress through the following three stages:

Stage1: The earliest change is inflammation of synovial membrane and the underlying connective tissue.

Stage2: Inflammatory granulation tissue (pannus) is formed, spreading over and under articular cartilage which is progressively eroded and destroyed.

Stage3: Fibrous adhesions may form between the layers of pannus across the joint space and fibrous or bony ankylosis may occur.

Additional Pathological Changes

- Muscles adjacent to inflammed joints atrophy and there may be focal infiltration with lymphocytes.
- Appearance of subcutaneous nodules.
- Similar granulomatous lesions may occur in the pleura, lung, pericardium and sclera.
- Lymph nodes are often hyperplastic, showing many lymhoid follicles.
- Periarticular osteoporosis is prominent adjacent to inflammed and functionally impaired joints.

Clinical Features

- The onset is gradual, with increasing pain and swelling of a joint.
- Any joint may be affected, but the incidence is higher in the peripheral joints such as the hand joints, wrists, feet, knees, and elbows than in the spine, shoulders, or hips.
- However the presentation of RA may be atypical in elderly patients. For example, a 'galloping' course, with an initial polymyalgic picture or with synovitis and marked peripheral edema
- A 'spindled' appearance of fingers and 'broadening' of forefoot in a typical case.

Progression

As the disease advances, muscle atrophy, tendon sheath and joint destruction results in

- Limitation of joint motion
- Joint instability
- Subluxation
- Correctable deformities
- Development of permanent contractures
- Complete disorganisation of the affected joint.

Characteristic Deformities

- Flexion contractures of the hands and feet, knees, hips and elbows.
- Anterior subluxation of MP joints with ulnar deviation of fingers.
- 'Swan neck' deformity.
- 'Button-hole' deformity.
- Dorsal subluxation of ulnar styloid of the wrist with rupture of 4th and 5th extensor tendons.
- Subluxation of MP joints which is followed by clawing of toes.
- Calcaneal erosions and valgus deformities at the subtalar joint.

Extra-articular Features

- *Systemic*: Fever,weight loss, fatigue, susceptibility to infection.
- *Musculoskeletal*: Muscle wasting, tenosynovitis, bursitis, osteoporosis.
- *Subcutaneous nodules*: Usually seen at the sites of pressure such as extensor surfaces of the forearms below the elbow, scalp, sacrum, scapula and Achilles tendon.

- *Hematological*: Anemia
- *Lymphatic*: Splenomegaly
- *Ocular*: Retinal changes
- *Vasculitis*: Raynaud's phenomenon, ulcers.
- *Cardiac*: Pericarditis, cardiomyopathy.
- *Pulmonary*: Pleural effusion
- *Neurological*: Neuropathies

Investigations

- *Serological tests*
  - Positive Rh factor
  - Raised ESR
  - Positive Rose Waaler's test
- *Synovial Analysis*
  The clarity, color and viscosity of synovial fluid can assist in diagnosis as well as D/D.
- *Imaging Techniques*
  X-rays are most commonly used.

Stages of Radiological Progression in RA

I. Periarticular osteoporosis
II. Loss of articular cartilage
III. Erosions
IV. Subluxation and ankylosis

Treatment

Rest and Constitutional Treatment

- Rest is beneficial, especially in the early stages of the disease and during an exacerbation.
- Hospitalization with skilled nursing, regular food and proper sleep, has a remarkably good effect on general health.
- Rest for individual joints with convenient light splints.
- Prevention of development of 'bed deformities'.
- Maintenance exercises.

Drugs

- Nonsteroid anti-inflammatory drugs (NSAIDs) in low doses, as older patients frequently take multiple drugs for other chronic ailments like diabetes or hypertension. Ibruphen, naproxen, diclofenac and nimusilide are some of the drugs commonly used to provide relief of pain and inflammation. However, these drugs do not protect against joint damage.
- Disease-modifying antirheumatic drugs (DMARDs) are best supervised by a consulting rheumatologist, e.g. methotrexate.
- Corticosteroids are indicated in patients with high fever and in extra-articular manifestations of RA.
- It should be remembered that older patients are at an increased risk of steroid-induced osteoporosis. Therefore doses are usually low and duration is also short.

Intra-articular Injections

Injections of corticosteroids can be used.
However, they have the following disadvantages:

- Risk of infection
- Risk of accelerating a degenerative reaction
- The short duration of relief
- Repeated injections at several sites may become irksome to the patient

Physiotherapy in Acute Phase

1. Correct bed posture and properly supported positioning of the involved joints.
2. Additional support to the limb with splints and sand bags.
3. Deep breathing exercises.
4. Full ROM and PRE of the joints and muscles free from immobilization and the active disease.
5. Functional mobility.
6. Preparation of upper extremities for future crutch walking.
7. No extrastrain on the affected joints
8. Isometrics
9. No heat therapy for swollen joints
10. TENS, IFT, US, Cryotherapy
11. Hydrotherapy.

Physiotherapy in Chronic Phase

- Thermotherapy
- Active and functional therapeutic programs
- Stretching procedures
- Exercises to improve strength and endurance of the muscles related to the affected joints.
- Gait training.

Surgery

- Synovectomy in early stages
- Repair or replacement of ruptured tendons
- Correction of deformity
- Osteotomy
- Arthroplasty
- Arthrodesis.

GOUT ARTHRITIS

Gout is the clinical manifestation of a disturbed purine metabolism. It is characterized by deposition of uric-acid salts – especially sodium biurate in connective tissues such as cartilage, the walls of bursae and ligaments.

Epidemiology

- Predominantly a problem of postpubertal males.
- Seldom seen in women before the menopause.
- Serum uric acid levels are higher in urban than in rural communities and are positively correlated with intelligence, social class, weight, hemoglobin, serum proteins and a high protein diet.

Etiology

- The precise cause of the disturbance of metabolism is unknown.
- Various genetic and environmental factors lead to hyperuricemia and gout by decreasing the excretion of uric acid and / or increasing its production.
- Renal failure, lead poisoning, Hyperparathyroidism, myxodema, lactic acidosis.
- HGPRT deficiency, PRPP synthetase overactivity.

Pathology

- Increased level of urate in the plasma.
- Deposition of sodium salt in the form of crystals in certain connective tissues.
- The deposited crystals set up an inflammatory reaction.
- Restoration of tissue to the normal in acute gout.
- Considerable disorganization of the joint in chronic gout.
- Tophi are also common at various other sites like olecranon bursa and cartilage of the ear.

Clinical Features

- *Age*: over 40 years
- *Sex*: Men are more affected than women
- *On set*: May be insidious or explosively sudden, often waking the patient from sleep.
- *Chief clinical manifestations*: Arthritis and bursitis
- Polyarticular and upper extremity attacks are more common in elderly patients.
- The MP joint of a great toe is the site of the first attack of acute gouty arthritis in 70 percent of patients; the ankle, the knee, the small joints of the feet and hands, the wrist and elbows follow in decreasing order of frequency.

Chronic Gout

Recurrent acute attacks are followed by:

- Progressive cartilage and bone erosion
- Hard and tender nodule known as “chalk stones” or “tophi” – frequently found in the cartilage of ear, bursae and tendon sheaths
- Secondary degenerative changes
- Gross joint deformities
- Severe functional impairment

Investigations

- Raised plasma uric acid content
- A mild leucocytosis
- ESR may be increased
- Aspiration of swollen joints may yield a small quantity of turbid fluid, but never organisms.
- Polarized light microscopy of synovial fluid usually reveals crystals.

Radiographic Examination

- No radiopgraphic change in acute attacks of gout.
- Punched-out erosions adjacent to the joint.

Diagnosis

- A history of previous attacks, with symptom-free intervals.
- A raised plasma urate content.
- The presence of tophi in the ears or elsewhere.
- Detection of crystals in synovial fluid.
- A favorable response to treament

Treatment

- Start treatment as early as possible.
- Use adequate doses.
- NSAIDs are the agents of choice.
- Rest to affected joint.
- Lithium ionisation in between attacks.
- Cryotherapy or other nonthermal modalities to reduce pain and inflammation.

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8 Falls in Elderly

- Definition
- Prevalence
- Risk Factors
- The Role of Balance Control
- Age-related Changes in Balance and Gait Pattern
- Assessment and Evaluation
- Treatment

DEFINITION

An event that results in a person's inadvertently coming to rest on the ground or lower level with or without loss of consciousness of injury. This excludes falls from major intrinsic event (seizure, stroke, and syncope) or overwhelming environmental hazard.[1]

PREVALENCE

Falls are extremely common among the elderly population accounting for substantial morbidity and mortality. Approximately, 30 percent of people over the age of 65 fall each year.[2] In about 3 percent of falls, the older adult lies on the floor for at least 20 min. Up to 20 percent of community dwelling elderly persons fall each year in the US and this figure has doubled in institutionalized ambulatory populations.[3,4] These falls have serious immediate as well as long term complications. Nearly 200,000 aged Americans have a fracture of the hip each year usually during a fall and often with little obvious environmental provocation.[5] About 10 percent of falls require hospitalization due to fractures and other injuries. Approximately, 50 percent of fall injuries seen in an emergency room will have continued pain and mobility limitations.[2]

RISK FACTORS

Risk factors associated with the occurrence of falls in elderly are classified as (i) intrinsic or host factors and (ii) extrinsic or environmental factors.

- *Intrinsic factors*
  - Poor balance
  - Weakness
  - Foot problems
  - Visual impairment
  - Cognitive impairment
- *Extrinsic factors*
  - Poor lighting
  - Slippery surface
  - Obstacles
  - No safety equipment
  - Loose carpets
  - Polypharmacy

Current research indicates that falls in the elderly are typically multifactorial. Lipsitz[6] and his colleagues followed a group of community dwelling older adults over 70 years of age for 1 year and identified all falls that occurred. They found that a number of factors were associated with an increased risk of falling including reduced physical activity, reduced proximal muscle strength and reduced stability while standing. Other significant factors included arthritis of the knees and impairment of gait, hypotension and the use of psychotropic drugs. The conclusions of this study were that most falls in older adults involve multiple risk factors and that many of these factors may be remediated. Thus it is suggested that the physical therapist who is working with older adults should determine both intrinsic and extrinsic factors associated with a particular fall and reduce or correct as many of these as possible.

THE ROLE OF BALANCE CONTROL

The study of intrinsic factors leading to falls has included examining the role of balance control. Several researchers including Tinetti from the US[7] and Berg from Canada[8] have measured functional skills related to balance in order to identify people at high risk for falls. Functional skills included sitting, standing, walking, unsupported standing and reaching forward, performing a 360° turn and moving from sit to stand position. A more recent approach to understanding balance function in the elderly examines specific variables relating to normal postural control and determines the extent to which deterioration in their function contributes to loss of stability in the elderly. It may be recalled that normal postural control is composed of three components:

1. *Sensory input* continually provides information about the body's position and trajectory in space. Sensory data critical to balance comes from visual, vestibular and somatosensory input.
2. *Central processing* can be regarded as the process of "setting up" the postural response. It involves sensory cortex, frontal and motor cortex, brainstem, basal ganglia and cerebellum.
3. *Effector output* constitutes the biomechanical apparatus through which the centrally programmed response is carried out. It involves upper and lower motor neurons, muscles and joints.

Age-related and/or pathological changes in any of these three components of postural control will increase the risk for falls in elderly. Nevertheless, all of them are potentially remediable with intervention.

AGE-RELATED CHANGES IN BALANCE AND GAIT PATTERN

Let us discuss these changes under the following headings:

- Musculoskeletal changes across age
- Changes in posture across age
- Changes in temporal and distance parameters of gait across age.

Musculoskeletal Changes Across Age

When the balance of a young adult is disturbed by a movement of support surface he or she typically regains stability by using ankle movement strategy, in which, postural sway is focused at the ankle joint and muscle response are activated first in the stretched ankle muscles and then radiate upward to the muscles of the thigh and hip. Woollacott, Shumway-Cook and Nashner compared the muscle response characteristic of older adults and young adults and found that the response organization was generally similar between the older and younger groups with regard to responses being activated first in the stretched ankle muscle and radiating upwards to the muscles of the thigh.[9] However, the older adults showed significantly slower onset latencies in response to anterior platform movement causing backward sway.[10,11] In addition in some older adults, the muscles response organization was disrupted with proximal muscles being activated before distal muscles. The older adults group also tended to co-activate the antagonistic muscles along with the agonist muscles at a given joint significantly more often than the younger adults.

Changes in Posture Across Age

Older adults were found to activate some predominant postural muscles, as did the young adults. The primary age-related differences in the postural responses were found to be a combination of longer onset latency, longer onset duration and a smaller burst magnitude in older adult's postural responses as compared with those of young adults. The combination of these resulted in a less effective balance recovery strategy in the older adults. The composite effect of the postural muscle activity in the older adults probably led to a slower rate of generating postural activity. Furthermore, these insufficient postural responses from the leg muscles often led to a backward lean of the trunk. Older adults were found to more frequently use arm movement to assist in trunk stabilization and prevent a fall.[12]

Decreased range of motion[13] and loss of spinal flexibility in many older adults can lead to a characteristic flexed or stooped posture. This can be associated with other changes in postural alignment including a shift in the vertical displacement of the center of body mass backward towards the heel.

Changes in Temporal and Distance Parameters of Gait Across Age

During walking older adults often assume a more rigid and guarded posture than do young adults. Crownishield et al[14] found that adults over the age of 60 years showed decrease in the

peak hip joint movement, when compared with adults aged 22 to 30 years. This decrease was found to be related to the shorter stride length in the older adults. Therefore, it is possible that because of the decreased ability to control upright posture of the upper trunk in the saggital plane. Older adults adopt a smaller stride length to reduce the ground reaction force in turn deceases the balance challenges to the upper stability of the upper body in the saggital plane.

Chen et al[15] investigated whether the minimum response time allowed to modify gait pattern to avoid an obstacle during walking would be different between older and young adults. The obstacle used was a band of light located at a predicted foot placement. This virtual obstacle could be lit up a different time prior to the subject's heel strike. The time allowed for gait modification before heel strike ranged between 200 and 450 milliseconds with increments of 50 milliseconds. The rate of success in avoiding the obstacle was higher for young adults than for older adults regardless whether the time allowed to make modification to gait was long or short. These findings imply that the older adults need longer time to implement gait modifications to prevent running into an obstacle on the walking path.

Older adults shortened the stride length after the slip, whereas young adults did not shorten their stride length. This shortened stride length could partially be accounted for by the longer co-activation time between the rectus femoris and biceps femoris muscles of the non-perturbed leg compared with the young adults. The shortened step length while crossing an obstacle increased the likelihood of tripping for the older adults.

Thus, it is evident from the above discussion that comprehensive assessment of the older faller must include not only the evaluation of physiologic impairments but also the assessment of both static and dynamic balance.

ASSESSMENT AND EVALUATION

- *History*
  - A. *Circumstances of fall*: Includes
    - *Environmental circumstances*: Including location, floor surface, lighting, quality of chair.
    - *Direction*: Forward falls typically indicate a trip whereas backward falls usually indicate a slip. Tripping falls may occur because of impaired depth perception or poor foot clearance. Backward falls may suggest CNS disease with a lesion in cerebellum, brainstem or basal ganglia.
    - *Activity at the time of fall*: Helps in understanding the cause of fall. For example, a fall while rising from a chair indicates muscle weakness or nervous disease.
    - *Recent meal or alcohol intake*: For example, a fall occurring 30 minutes after a meal may be due to postprandial hypotension.
  - B. *Associated symptoms*: For example, lightheadedness, vertigo, weakness, confusion palpitations
  - C. *Relevant comorbid conditions*: For example, prior stroke, cardiovascular disease, parkinsonism, osteoporosis, anaemia, diabetes mellitus, depression, anxiety, cognitive impairment.
  - D. Previous falls
  - E. Review of current as well as past medications, particularly those having hypotensive or psychoactive effects.

- *Physical evaluation*
  - *Vision*: Visual impairments related with the occurrence of falls include poor distant vision, decreased visual field, reduced contrast sensitivity, impaired depth perception and cataract. Therefore, the visual examination should include
    - assessment of visual fields
    - assessment of distant vision with or without distance lenses
    - fundoscopic examination
  - *Vestibular function*: Vestibular dysfunction related with the occurrence of falls includes classic symptoms of vertigo or dizziness. The examination should include
    - *Head-thrust test*: The patient is asked to look at the examiner's nose while the examiner rapidly move the patient's head to the right and left. Small, rapid eye movements indicate a positive head-thrust test.
    - *The Dix-Hallpike maneuver*: A positive response is indicated by nystagmus and vertigo lasting for 10-30 sec and reproduced within a few seconds of rapidly positioning a patient from seated to supine with the head turned 45°.
    - *Romberg test*: The patient is instructed to stand with the feet together for 10 sec, first with the eyes open and then with eyes closed. Grading is simple: able or not able to complete the task.
  - *Cardiovascular function*:
    - Pulse and BP
    - Cardiac arrhythmias
    - Orthostatic hypotension
  - *Musculoskeletal function*
    - ROM
    - Arthritic changes
    - Leg length discrepancy
    - Skeletal deformities such as genu varus or valgus
    - Muscular weakness
    - Foot problems
  - *Neurological function*
    - Sensations, particularly touch, kinesthesia and proprioception
    - Reflexes
    - Muscle tone
    - Cortical, cerebellar and extrapyramidal tract functions
  - *Cognitive function*: (Appendix-IV)
  - *Balance and gait*: (Appendix-VII)
  - *Mobility*: (Appendix-III)

TREATMENT

Table 8.1 describes a comprehensive approach of treatment based on following principles:

- Identification and treatment of underlying reversible deficits
- Identification and compensation for irreversible deficits
- Prevention to reduce repetition of incidence and fear of falling

Table 8.1: A comprehensive approach of treatment of falls in elderly

Deficit/risk factor	*Therapeutic/Preventive strategies*
Postural hypotension	Elevation of head of bed, ankle pumps or hand clenching, pressure stockings, caffeine 100 mg with meals, Fludrocortisone 0.1 mg qd-tid, if indicated.
Environmental hazards	Improved lighting, appropriate furniture, protective hip padding, improved floor surface, providing railing on both sides, mark edges of steps with contrasting tape.
Vision deficits	Maximum lighting in home with reduction in glare, use of distance lenses
Use of pshychotropic medications	Education about the appropriate use of sleep aids or hypnotic agents, sleep restriction, tapering and discontinuation of medications
Impairment of gait	Gait training as described in chapter V
Decreased ROM, muscular strength or endurance	Physical therapy as described in chapter VFunctional activities
Sensory loss	Use of a cane or walking stick
Cervical osteoarthritis, vestibular deficit, parkinsonism	Move kitchen, bedroom and commonly used closet items to shoulder level
Dementia	Avoid multitasking
Balance problems	Balance training (Table 8.2)
Leg length discrepancy	Shoe raise
Dizziness	Gaze stabilization exercises, e.g. perform one set rotating head from side to side in horizontal plane as fast as possible at a rate that is below threshold for blurring of image, for a maximum of 2 min nonstop

Table 8.2: Balance training

Deficits	*Therapeutic intervention*
Not able to maintain Romberg, half tendem or full tendem position	Practicing effective balance responses at the level that presents difficulty
Not able to maintain one-legged stance (unsupported)	Asking the patient to frequently repeat the task with two than one hand support followed by using minimal pressure to get assistance from one hand.
Limited reaching	Functional activities that stress the margin of the stability of a patient, e.g. catching a ball from the right side, reaching for a jug of milk, leaning forward to operate oven or leaning backward to put a pen on the table behind.
Asymmetrical mediolateral or anteroposterior weight-bearing	Weight-shifting techniques so as to elicit balance responses,Standing on sloping surface, using electronic feedback for proprioceptive training (Fig. 8.1).
Reduced velocity of normal walk	Gait training as described in chapter V
Lack of control in sit-to-stand	Chair-rising strategies, e.g.
Unable to step up and down without assistance	Muscle strengthening of lower extremity Practicing on stairs
Excessive contraction, stiffness or breathholding while maintaining balance	Relaxation techniques
Not able to maintain balance during 360° turns	Body awareness training techniques such as tai chi, Maintenance of vertical segmental alignment, widening steps, turning body by pivoting on toe of nonweight-bearing leg after a step taken during 360° turn.

Fig. 8.1(a): Electronic feedback for proprioceptive training

THE PROPRIOCEPTIVE EXERCISE

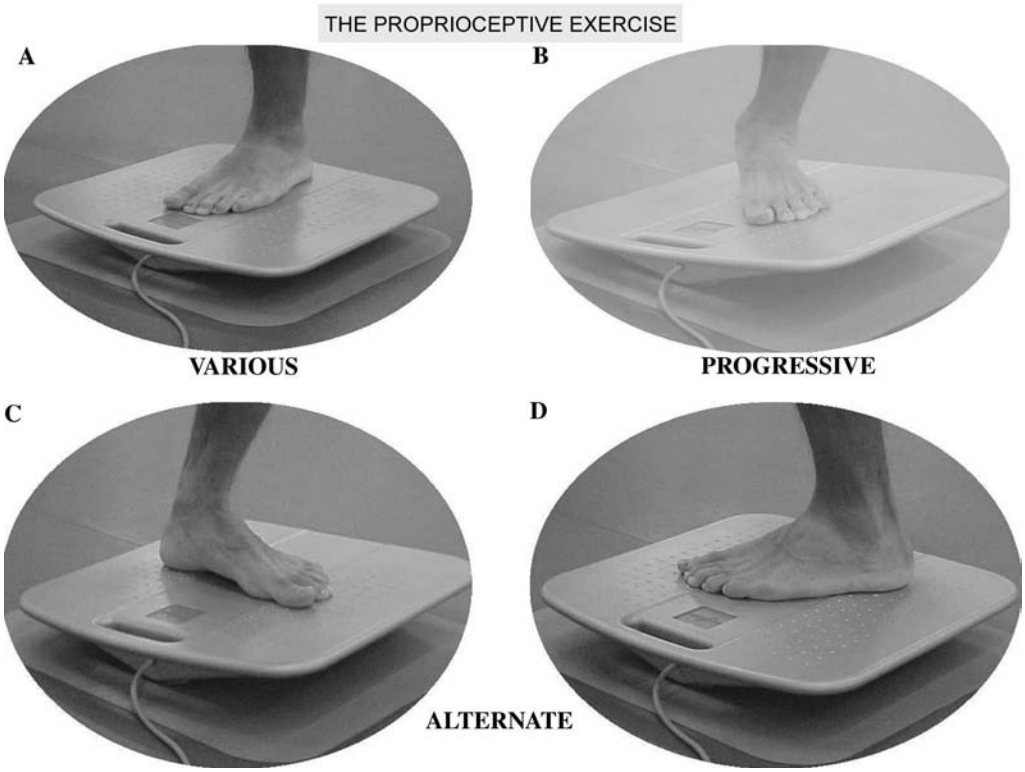

Fig. 8.1(b): Electronic feedback for proprioceptive training

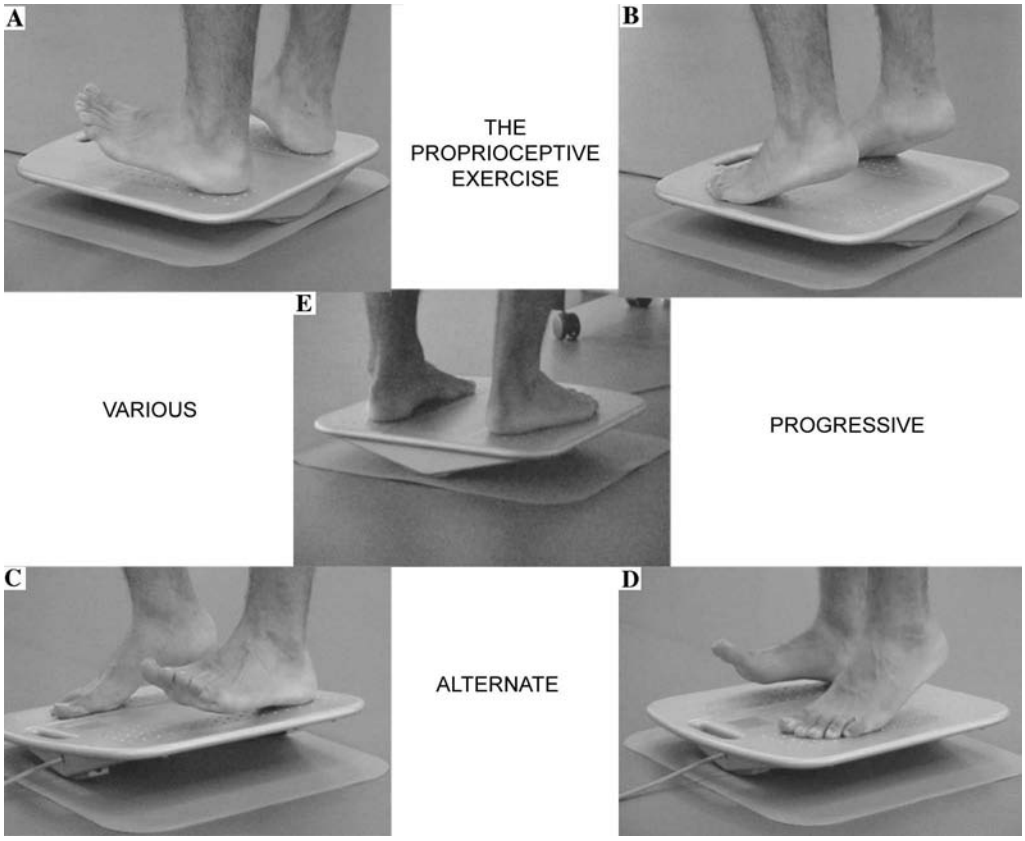

Fig. 8.1(c): Electronic feedback for proprioceptive training

To Summarize

Multifactorial therapeutic intervention is effective in treating as well as preventing falls in elderly populations. Exercise program, particularly balance training, should be administered as a vital component of multifactorial therapeutic intervention.

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9 Neurological Disorders in Elderly

- **Stroke**
- **Parkinson's Disease**
- **Peripheral Neuropathy**

STROKE

Definition

A stroke is usually understood to be the sudden onset of neurological deficits due to local disturbances in the blood supply to the brain, i.e. a vascular occlusion (ischemic infarct) or a vascular disruption (hemorrhage).[1]

Prevalence

Prevalence of stroke rapidly increases with age. Two thirds of stroke patients are found in the over-65 age group.

Morbidity and Mortality

Stroke is the third most common cause of death and the leading cause of disability in developed countries. In the United States, the rate of death due to stroke is 160,000 per year.[2] Wagenaar and Kwakkel reported that about 30 percent of the stroke patients died within 21 days. Of those who survived the acute phase, 42 percent remained dependent upon other persons for their ADLs, 24 percent were hospitalized or sent to a nursing home, 11 percent were unable to walk, and 66 percent were unable to return to work.[1] On the basis that elderly is the fastest growing segment of world population, it may be expected that the proportion of disability will continue to increase considerably.

Risk Factors

- *Age:* After age 55, the risk for stroke doubles every 10 years.
- *Sex*: Male > female for all age groups below 75 years.

- *Race*: Afro-Caribbean > Asian > European.
- *Diseases*: Heart diseases such as heart failure or atrial fibrillation, hypertension, diabetes, hyperlipidemia, polycythemia.
- *Lifestyles*: Smoking, excess alcohol consumption, obesity, diet, lack of physical activity
- Oral contraceptives.

Clinical Features

- The neurological deficit reflects the size and site of the lesion.
- At the time of onset, the level of consciousness is more depressed in patients with cerebral hemorrhage than those with ischemic stroke.
- Acute focal stroke presents with variable symptoms. Most common is a haemiplegia with or without the signs of focal higher cerebral dysfunction, for example aphasia. Other symptoms are related with sensory, visual, cognitive and language deficits.
- Subarachnoid hemorrhages are not common in elderly individuals. Typically they presents with a sudden, unusually severe headache that lasts for hours or even days, often accompanied by vomiting.
- Table 9.1 presents clinical features of most common forms of stroke.
- Following the onset of stroke with hemiplegia, a state of flaccidity exists from hours to weeks or months. This is followed by the development of patterns of returning muscle function and spasticity.

Table 9.1: Clinical features of most common forms of stroke

Ischemia	
• Middle cerebral artery	Contralateral paralysis and sensory deficit
	Aphasia
	Homonomous hemianopsia
	Hemineglect
	Numbness: face, arm > leg
	Apraxia
	Impaired ability to judge distance
	Loss of conjugate to opposite side
• Anterior cerebral artery	Weakness: leg > face, arm
	Numbness: leg > face, arm
	Urinary incontinence
	Contralateral grasp reflex, sucking reflex
	Amnesia
• Vertebrobasilar artery	Ataxia
	Dizziness, nausea, vomiting, nystagmus
	Dysmetria
	Dysarthria
	Dysphagia
	Visual field deficits
	Quadriplegia in complete basilar syndrome

Contd...

Contd...

Hemorrhage	
• Intracerebral hemorrhage	Headache Lethargy or coma Focal symptoms resembling ischemic stroke
• Subarachnoid hemorrhage	Severe, unusual headache, often during physical exertion There may be loss of consciousness or vomiting at onset Nuchal rigidity takes about 6 hrs to develop Cardiac symptoms such as chest pain, syncope, arrhythmias Focal hemisphere signs at onset due to an associated intracerebral hematoma Focal hemisphere signs developing after some days due to arterial vasospasm A 3rd nerve palsy due to local pressure from an aneurysm of the posterior communicating artery

Investigations

- CT/MRI: To confirm the vascular nature of the lesion
- ECG, ultrasound scanning, Doppler ultrasound, contrast angiography: To investigate the underlying vascular disease
- Serum glucose, complete cell and platelet blood count, cholesterol, prothrombin and partial thromboplastin time, electrolytes: To investigate the risk factors

Evaluation and Assessment

- *Level of consciousness*: The Glasgow Coma Scale records motor response to pain, verbal responses to auditory as well as visual clues, and eye opening.[3]
- *Cranial nerves*: Ocular movements; strength of facial muscles; labyrinthine auditory, laryngeal and pharyngeal function, should be checked.
- *Sensation*: Light touch, deep pressure, pain, temperature, kinesthesia, two-point discrimination, proprioception, appreciation of texture and size, and vibration should be assessed.
- *Musculoskeletal*: Muscle strength as well as range of motion especially ankle dorsiflexion and shoulder movements should be assessed thoroughly.
- *Movement pattern*: Physical therapist should know whether the movement produced is in normal pattern or not. Initiation pattern, sequencing and control of firing patterns, balanced return are the indicators of controlled smooth movement pattern.
- *Hypertonicity*: Physical therapist dealing with stroke patients should understand the difference between 'true spasticity' and 'hypertonicity'. According to Burke[5] and Sheean[6], 'true spasticity' depends upon afferent information from feedback following movement of the stretched muscle whereas hypertonicity which is a form of sustained efferent muscular hyperactivity, depends upon continuous supraspinal drive to the alpha motoneurones. This results into increased tonic muscle contraction which continues in the absence of movement. As a consequence, hypertonicity in hemiplegia gives rise to abnormal postures such as flexion of upper limb and extension of lower limb.

- *Pain*: Shoulder pain is the most common pain complaint after stroke.[10] It can be assessed by using Visual Analogue Scale.
- *Edema*: The distal parts of extremities should be observed for the presence of edema.
- *Communication*: Physical therapist should be aware of aphasia or dysarthria as well as alternate modes of communication such as auditory or visual deficits.
- *Behavior*: Cognitive function and behavior problems should be noted, as discussed in chapter XI.
- *Balance*: The Berg Balance Assessment is easy to administer and has good reliability for stroke patients.[57]
- *Posture*: Postural problems in regard with alignment or rotation, midline orientation, and the position of extremities should be evaluated in detail.
- *Gait*: Gait pattern is an important component of evaluation of a hemiplegic patient. Loss of controlled planterflexion and normal combinations of movement patterns in swing and stance phases of gait, are some of the common abnormalities. Wisconsin Gait Scale (WGS)[58,59] provides the qualitative evaluation of the gait of hemiplegic patients. (Appendix- VIII)
- *Appliances*: Use or a need to use the assistive devices, splints for positioning, orthotic devices or wheelchair should be noted down.
- *ADLs*: (See Appendix-I and –II)

Management

- *Medical management*:
  - The hospital stay for acute stroke is usually 2 to 4 days.
  - Management starts with assessment of the "ABCs" meaning Airway, Breathing and Circulation.
  - A rapid reduction of blood pressure, especially in case of moderate elevation, should be avoided. This is to prevent acute exacerbation of the neurological deficit.
  - No treatment is recommended unless the systolic pressure is > 220 mm Hg.
  - If needed, intravenous B-blockers should be administered to reduce blood pressure.
  - Admission to neurointensive care unit is must in case of subarachnoid hemorrhage.
  - Patients should not be allowed to take food or liquid by mouth until swallowing function becomes normal.
  - Patients should lie flat in bed so as to avoid the worsening of ischemia.
  - Depending upon the stroke subtype, secondary prevention strategies should be initiated as soon as possible. For example, aspirin and other antiplatelet drugs reduce the risk of recurrence in noncardioembolic strokes.
- *Physical therapy interventions*: A number of treatment approaches, ranging from neurological exercise therapies to cognitive remediation programs for perceptual deficits, have been developed in last four decades. The frequently applied neurological exercise therapies are Neurodevelopmental Treatment (NDT) derived from Bobath method, Motor Relearning Program (MRP) by Janet Carr and Roberta Shepherd, Brunnstorm's Movement Therapy, Proprioceptive Neuromuscular Facilitation (PNF) technique and Electromyography Feedback Therapy (EMG).

The main problem of hemiplegic patients is that of abnormal coordination of movement patterns combined with abnormal postural tonus.[49] Therefore, according to Bobath, the

assessment and treatment of the patient's motor patterns is the only way of leading directly to functional use. In addition to it, muscles are not paralyzed and deficits of muscular activity can be remedied by their action in more normal functional patterns. Thus, basic concept of Bobath method is a holistic approach that deals with patterns of coordination and not with problems of muscle function. The method has undergone many changes from 1970 to 1990, but the underlying concept has not changed. These changes can be summarized as following:[50]

- All static ways of treatment like 'reflex-inhibiting postures' have been discarded.
- A strong emphasis on movement and functional activity has been introduced.
- New ways of activating the patient through movements of the trunk have been found, combined with the inhibition of the spastic patterns of the limbs distally by the therapist.
- As the spasticity is reduced, patient is encouraged to control movements more and more distally, while the help of therapist is reduced.
- Treatment in supine is reduced for the patients who can sit or stand.
- More than ever before, all treatment is done in real life situations.

In 1985, Pat Davies introduced Neuro-Developmental Treatment (NDT) that is based on Bobath's approach; in it, the ideas of Bobath have been extended to training in functional tasks such as grasping, standing up, climbing stairs, bouncing a ball, getting dressed, preparing meals, washing clothes, brushing teeth and having a bath.[51]

Brunnstorm has described seven recovery stages in post-stroke hemiplegic patients[47]:

Stage 1. Flaccidity is present. No movement, on either a reflex or a voluntary basis, can be initiated.

Stage 2. Spasticity begins to develop. Flexion synergy in upper extremity and extension synergy in lower extremity may appear as associated reactions. There are minimal voluntary movement responses. (semivoluntary)

Stage 3. Spasticity reaches its peak. Patient is able to control the basic synergy patterns.

Stage 4. Spasticity begins to decline. Some movement combinations that do not follow the paths of basic limb synergies are mastered.

Stage 5. Spasticity continues to decline. More difficult movement combinations are mastered as the basic limb synergies lose their dominance.

Stage 6. As spasticity disappears, the patient becomes capable of a full spectrum of movement patterns. Coordination approaches normalcy.

Stage 7. Normal motor function is restored.

According to Brunnstorm, these stages of recovery following a stroke bear a resemblance to normal infantile motor development on a continuum from reflex to voluntary movement, from gross to fine movement and from control of proximal movements to that of distal movements. She developed the treatment strategies so as to facilitate this "natural and lawful" process. The techniques of facilitation used by her are synergies, reflexes, associated reactions, resistance, tapping and stretch.

With the exception of the training of basic functional activities such as grasping, sitting and walking, training for ADL is hardly discussed by Brunnstorm.[1] In addition to it, the use of reflexes and synergistic movement in treatment is controversial and the concept of the hierarchical organization of the nervous system has been modified in neurophysiology in recent years.

However, Brunnstorm's observations of motor recovery and motor behavior are valid and the techniques are useful in treatment.[48]

The Motor Relearning Program (MRP), formulated by Carr and Shepherd, is an approach to functional training.[52] There is a major shift, in emphasis, away from the exercise or facilitation therapy to the relearning of motor control. In view of these applied movement scientists, the unique contribution of physiotherapy to the rehabilitation of stroke lies potentially in the training of motor control based on an understanding of the kinematics and kinetics of normal movement, motor control processes and motor learning. Thus, MRP is based on four factors known to be essential for the learning of motor skill and therefore assumed to be essential for the relearning of motor control following stroke:

- The elimination of unnecessary muscle activity
- Feedback
- Practice
- Interrelationship between postural adjustment and movement

The research studies have indicated that all of the available approaches appear to promote improvement in functional ability.[53] A better theoretical understanding of the deficits In author's view, a treatment program consisting of mainly three components may be useful:

I. Traditional techniques of exercise therapy
II. The specific treatment approaches
III. Function-based techniques

- *Passive movements*: In a recent study, it has been demonstrated that passive elbow movements in hemiplegic stroke patients before clinical recovery elicit some of the brain activation patterns described during active movement after substantial motor recovery.[4] This indicates that the recruitment of ipsilateral sensory and motor pathways early after stroke may be critical for return of voluntary control. Therefore, it is recommended that patient should be involved actively while performing passive movements in the early stage after stroke. He must be instructed to pay attention towards the position of joints, stability of proximal parts, movement of distal parts and the segmental alignment (Fig. 9.1).

Fig. 9.1: Therapist passively moving the shoulder joint

In the recovery stage, passive movements are performed to get complete elongation of the shortened muscle groups. The pattern of elongation for an upper extremity is scapular protraction and upward rotation, shoulder lateral rotation and abduction, elbow extension, forearm supination, and wrist and finger extension. According to Odeen[9], the elongation of the shortened muscle groups at the point of maximally tolerated muscle length results in the reduction of hypertonicity.

- *Active movements*: Patient should be encouraged to do the movements actively or better said voluntarily, as soon as the muscle function begins to return. However, it must be kept in mind that in hemiplegia, the return in muscle function is usually accompanied by the emergence of synergistic movement patterns.[44] Sahrmann and Norton have demonstrated that as voluntary function increases, the dependence on synergistic movement decreases.[45] This suggests that the patient must be encouraged to produce the movements voluntarily. Physical therapist may use her voice or touch to stimulate the patient's voluntary effort so as to produce the movements in the more normal patterns.
- *Functional stretching*: This is the process of elongation of the shortened muscle groups through weight-bearing (Fig. 9.2). In hemiplegia, "Functional stretching" rather than "orthopedic stretching" is more effective to improve range of motion.
- *Mobilization exercise*: Joint dysfunction of the shoulder, scapula, hand, fingers, ankle and forefoot may result as the secondary problem in hemiplegic patients. Mobilizing the scapula is particularly important to improve the mobility of arm at shoulder and also to prevent shoulder pain. This may be carried out in supine or side lying.
- *Progressive resisted exercise*: Weakness from stroke differs from generalized weakness and orthopedic weakness: it involves one entire side of the body and includes the trunk and

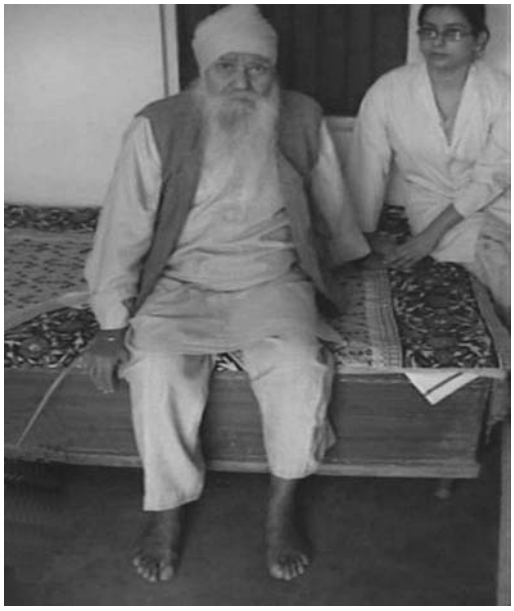


Fig. 9.2: Elongation of the shortened muscle groups through weight-bearing

extremities.[46] Traditionally, progressive resisted exercise was believed to cause a marked loss of coordination and an increase in co-contraction. Therefore, this exercise was avoided to the patients post-stroke. However, the latest studies have reported that patients with hypertonicity may get benefit from progressive resisted exercise.[7] (Fig. 9.21)

- *Aerobic exercise*: Aerobic exercise is advised to patients of hemiplegia to improve the functional status. The research studies have indicated that aerobic exercise has the potential to develop the overall sensorimotor function after stroke.[8] Walking on a treadmill, in particular, has produced impressive positive findings in terms of independent walking.[54] (Fig. 9.22)
- *Functional activities*: The functional approach is well accepted by the patient. It makes the treatment more meaningful. It includes task-specific activities such as
  - Rolling
  - Sitting control
  - Sit to stand
  - Standing control
  - Transfers
  - Gait
  - Reaching activities
- *Gait training*: In hemiplegic gait, there is disordered frequency, or phase relationship, between pelvic and thoracic rotation and arm and leg movements. This may be due to a lack of timing within coordination patterns and the general inability to switch between coordination patterns.[1] The training of essential components of walking can be started in early stage. Examples of some of the activities are as following.
  - Stimulating planter aspect of foot in supine lying. This may facilitate dorsiflexion of foot. (Fig. 9.3)
  - Extending hip with knee flexion over the side of the bed. (Fig. 9.4) This may prepare the affected leg for the start of swing phase.

Fig. 9.3: Stimulating planter aspect of foot in supine lying

Fig. 9.4: Extending hip with knee flexion over the side of the bed

- Controlling hip movement while flexing the knee keeping ankle in dorsiflexion on affected side, in the position of supine lying. This may prepare the affected leg for swing phase. (Fig. 9.5)
- Controlling knee flexors both eccentrically and concentrically throughout a small range in prone lying. This may train flexion of affected knee at start of swing phase. (Fig. 9.6)
- Pelvis bridging in supine lying. This may facilitate extension of both hips. (Fig. 9.7)
- Pelvis bridging on affected leg. This may facilitate extension of affected hip. (Fig. 9.8)
- Weight transfer from side to side in sitting. This may facilitate balance reactions. (Fig. 9.9)

Fig. 9.5: Controlling hip movement while flexing the knee keeping ankle in dorsiflexion

Fig. 9.6: Controlling knee flexors both eccentrically and concentrically throughout a small range in prone lying

Fig. 9.7: Pelvis bridging in supine lying

Fig. 9.8: Pelvis bridging on affected leg

- Training the quadriceps for eccentric and concentric activity in sitting (Fig. 9.10)
- Standing with arms in extension held by therapist. This may facilitate extension of affected hip. (Fig. 9.11)
- Stepping forward and backward with normal leg, keeping affected hip and knee in extension. This may facilitate weight bearing and balancing on affected leg. (Fig. 9.12)
- Stepping up and down with normal leg (Fig. 9.13).
- Shifting body weight from one foot to another in standing. This may facilitate training of lateral horizontal pelvic shift (Fig. 9.14).
- Practicing controlled knee flexion in standing. This may train flexion of affected knee at start of swing phase. (Fig. 9.15)

Figs 9.9A and B: Weight transfer from side to side in sitting

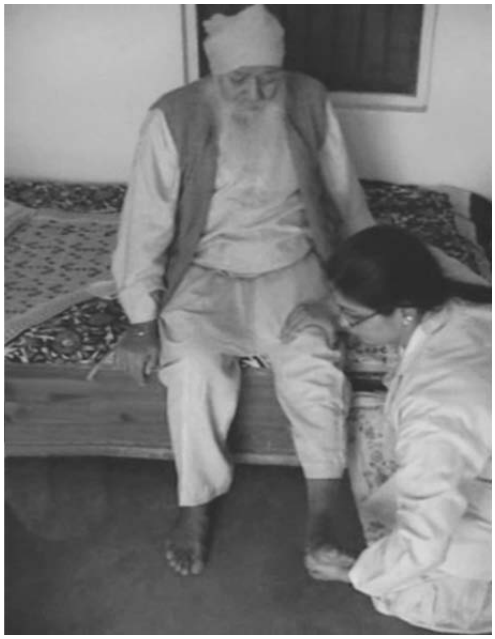


Fig. 9.10: Training the quadriceps for eccentric and concentric activity in sitting

Fig. 9.11: Standing with arms in extension held by therapist

Fig. 9.12: Stepping forward and backward with normal leg

Fig. 9.13: Stepping up and down with normal leg

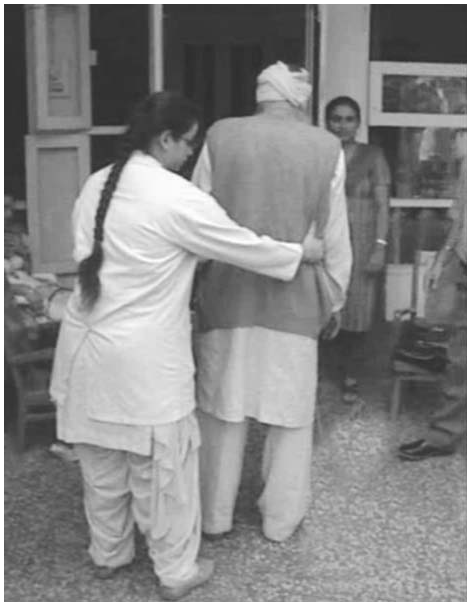


Fig. 9.14: Shifting body weight from one foot to another in standing

Fig. 9.15: Practicing controlled knee flexion in standing

- Shifting body weight forward so as to put heel down while therapist holds the affected foot in dorsiflexion with knee in extension. This may prepare the patient for heel strike. (Fig. 9.16)
- Bearing weight on affected leg. This may facilitate balance reactions. (Fig. 9.17)
- Rotating pelvis while walking. This may facilitate lateral rotation of both legs, in addition to improving balance and walking pattern. (Fig. 9.18)
- Walking sideways (Fig. 9.19)

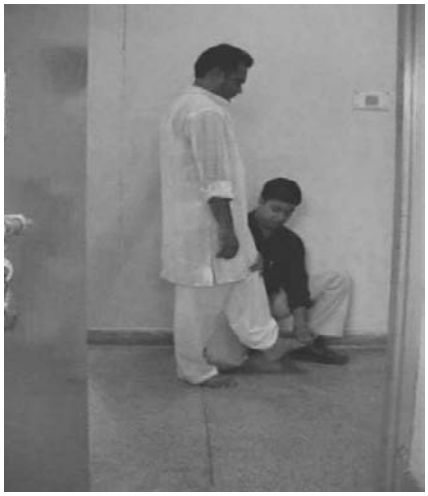


Fig. 9.16: Shifting body weight forward so as to put heel down while therapist holds the affected foot in dorsiflexion with knee in extension

Fig. 9.17: Bearing weight on affected leg

Fig. 9.18: Rotating pelvis while walking

Fig. 9.19: Walking sideways

- Walking sideways while crossing the legs. (Fig. 9.20)
- Improving walking velocity. This may cause positive influence on the disordered coordination patterns in trunk rotation and arm and leg movements.

PARKINSON'S DISEASE

Definition

Parkinson's disease (PD) is a progressive neurodegenerative disease that is characterized by rigidity, bradykinesia, resting tremor, mask like face and postural abnormalities. The disease was first described by Parkinson in 1807.

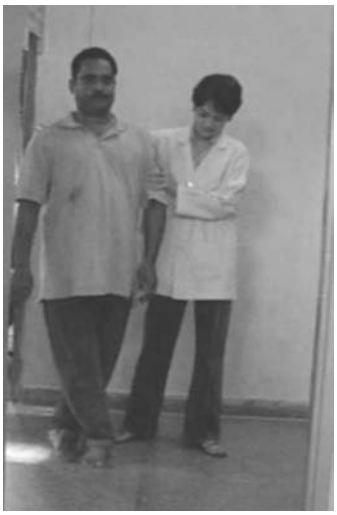


Fig. 9.20: Walking sideways while crossing the legs

Fig. 9.21: Resisted exercise using medicine ball

Fig. 9.22: Cycling as aerobic exercise

Prevalence

The prevalence is approximately 1 percent in the general population, with the rate rising from 0.6 percent for ages 60-64 to 3.5 percent for ages 85-89.[12]

Risk Factors

PD results from a reduction in the neurotransmitter dopamine stores of the substantia nigra with a consequent loss of pigmentation in this structure. Though the exact cause is unknown, many risk factors have been identified:

- *Toxic exposure*: Several studies have identified a link between PD and the exposure to pesticides, insecticides, herbicides and well water.[13,14]
- *Genetics*: Individuals with family history, particularly first-degree relatives of patients with PD are at approximately twice the risk for the disease.
- *Aging*: Dopamine shows an increase in concentration very early in life, followed by a rapid decrease from 5 to 20 years of age and a slow continuous loss from age 20 to 80 years.[15]
- *Infections*: A high rate of postencephalitic parkinsonism suggests the important role of infection in the incidence of PD.
- *Medications*: Medications such as antipsychotic agents, Lithium, metroclopramide are known to be associated with parkinsonism.

Clinical Features

The triad of resting tremor, bradykinesia and rigidity is the key feature of PD.

- *Tremor*: Though resting tremor is often considered the hallmark of PD, about 20 percent of parkinsonian patients will lack tremor. The features of tremor with special reference to PD are described as below:
  - Present at rest
  - Has a regular rhythm of about 4 to 7 beats/sec

  - Usually disappears with movement
  - Rarely interferes with ADL
  - No tremor during sleep
  - Some patients may have a postural tremor
  - "Pill-rolling": The patient appears to be rolling a pill in his fingers as the wrist cycles between pronation and supination
- *Bradykinesia*: Bradykinesia is a term used to describe the slowness in the execution of movement, whereas akinesia refers to the paucity of movement and 'freezing'or an inability to move.[19-22] In part, disorders of posture and locomotion found in the patients of PD are attributed to bradykinesia.[26] There is reduced magnitude of agonist muscle activity associated with an excessive co-contraction of the antagonist during movement.[23,24] The features of bradykinesia and akinesia with special reference to PD are described as below:
  - An impairment in the initiation of movement
  - Delay in the reaction time
  - Decreased ability to stop the movement once it is started
  - Lack of spontaneous or associated movements, e.g. arm swinging during walking
  - Abnormally small amplitude movements, e.g. small steps during walking or micrographia, i.e. reduction in the size of the written word
  - Complex movements are more involved than simple movements[27,28]
  - Internally generated movements are more affected than those which occur in response to sensory stimuli[19,25]
  - Difficulty in performing two separate movements simultaneously[19]
  - No advance planning for the next movement while the present movement is in progress[28,29]
  - Repetitive movements show a decrease in amplitude and ultimately fade out.
- *Rigidity*: Rigidity is one of the cardinal features of Parkinsonism. Clinically, it is defined as an increased resistance to stretch and the inability to achieve complete muscle relaxation.[11] The features of rigidity with special reference to PD are described as below:
  - Rigidity is not due to an increase in gamma motor neuron activity, a decrease in recurrent inhibition or a generalized excitability in the motor system.[16]
  - Excessive and uncontrollable supraspinal drive to alpha motoneurones is the most important cause of rigidity in PD.[17]
  - Rigidity might increase energy expenditure.[18] This may be perceived as increased effort on movement or the feeling of post exercise fatigue.
- *Postural instability*: Postural instability is the hallmark of stage III disease. Patient becomes more and more flexed as the condition deteriorates.[31] This results into reduced rotation and forward shifting of center of gravity and makes the patient more prone to falls. There are balance difficulties, even when the patient is seated. More than 1/3 of all patients with PD fall and over 10 percent fall more than once a week.[32]
- *Gait*: The characteristic features of the gait of parkinsonian patient are shortened stride, festination, loss of arm swing and increased cadence. Patients take increasingly fast but short steps in order to position their lower limbs under their flexed trunk. Instead of a heel-toe progression there may be a flatfooted or, with disease progression, a toe-heel sequence. This results into the decreased ability to step over obstacles or to walk on carpeted surfaces.[15]
- *Other symptoms*: Several other symptoms are also associated with PD. For example:
  - Mask like face

- Reduced blinking of the eyes
- Slowing of speech with a decrease in volume
- Cognitive changes such as depression or dementia
- With the progression of the disease other symptoms may get involved. For example, pulmonary infection or gastrointestinal dysfunction such as dysphagia and constipation or autonomic dysfunction such as postural hypotension

Course of the Disease

PD is a progressive disease with insidious onset. The rate of progression is variable. Table 9.2 displays the Hoehn and Yahr's staging of Parkinsonism.[33]

Table 9.2: Hoehn and Yahr's staging of parkinsonism

Stage	*Description*
Stage I	Unilateral involvement only; little or no functional impairment
Stage II	Bilateral or midline involvement, no balance impairment
Stage III	Impaired postural reflexes and difficulty with balance, still able to walk independently, mild to moderate disability, still physically capable of leaving independent lives in most cases
Stage IV	Severely disabling disease; patient can not get out of bed or chair unassisted but is able to walk independently, however unsteadily, once up
Stage V	Bedridden or wheelchair-bound; can not ambulate independently

Evaluation and Assessment

- PD is revealed by itself over the time
- The diagnosis is based on history and physical examination
- No laboratory or imaging studies are available to diagnose PD
- Physical examination should focus on the degree of tremor, bradykinesia, rigidity, balance and gait impairments
- The overall disability can be evaluated by using Parkinson's disease evaluation form[34] (Appendix IX).

Management

- *Pharmacotherapy*:
  - The aim of pharmacotherapy is to provide the symptomatic relief by replacing or compensating for lost dopaminergic neuron activity.
  - No drug is capable to delay disease progression
  - With mild severity of disease, it is better to delay pharmacotherapy until symptomatic relief is needed
  - Levodopa is the most commonly used drug in the treatment of PD
  - Dopamine agonists are most commonly used as an adjunct to levodopa.
- *Nonpharmacotherapy*:
  - Education to patient and care-givers includes the thorough explanation of the progressive nature of the disease as well as the importance of home exercise program.

- *Nutrition*:
  i. A high-fibre diet and sufficient fluid intake to reduce the severity of constipation, which is a common complaint in PD.
  ii. Calcium and vitamin D supplementation to improve bone health.
  iii. Protein restriction, especially in later stages of the disease, to reduce amino acid competition with levodopa for absorption.
- Speech therapy to assist tongue dysfunctions and improve voice volume

Physical therapy: Although, therapeutic intervention can not halt or reverse the progressive disability, it helps in enhancing the quality of life throughout the course of disease. Thus, early and ongoing physiotherapeutic intervention is essential to prevent secondary complications and maintain function in PD. Physical therapist should determine the causative factors and then administer the appropriate treatment strategies to attain the status of maximum functional independence.

- *Relaxation techniques*: This is a vital component of treatment program with an aim to reduce rigidity. Physical therapist should remember that unless and until the rigidity is reduced, it is difficult to initiate the movements. In addition to it, relaxation techniques may help in reducing the tremor. The techniques used may be:
  i. Gentle, slow rocking movements (Fig. 9.23)
  ii. Rotation of extremities and trunk (Fig. 9.24)
  iii. Savasana
  iv. Biofeedback
  v. PNF techniques
- *Active ROM and stretching exercises*: These are especially important in the earlier stages of PD, to prevent shortening of muscle because in PD, the contractile elements of flexor muscles become shortened, whereas those of the extensor muscles become lengthened.[35] Scapular and pelvic mobility should be given special emphasis. Physical therapist should remember that
  i. Sitting is the better starting position then supine lying because rigidity may be increased in the later position.[37]

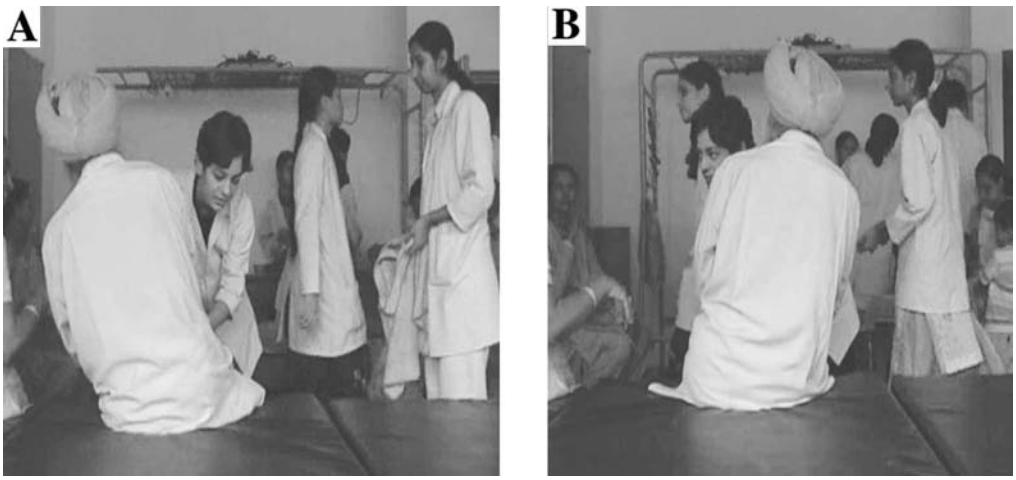


Fig. 9.23A and B: Gentle, slow rocking movements

Fig. 9.24A: Rotation of neck towards left

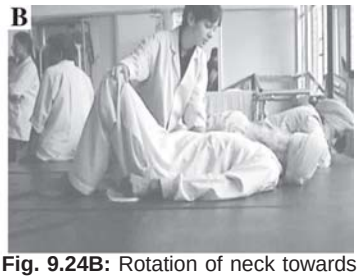


Fig. 9.24B: Rotation of neck towards right

Fig. 9.24C: Medial rotation of left shoulder

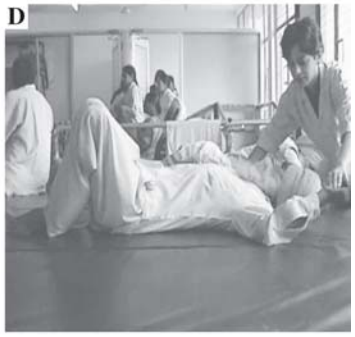


Fig. 9.24D: Lateral rotation of left shoulder

Fig. 9.24E: Rotation of lower trunk towards left

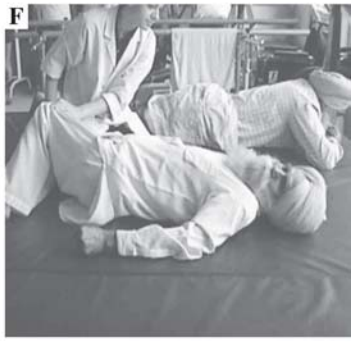
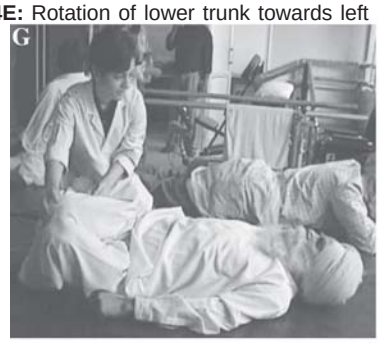
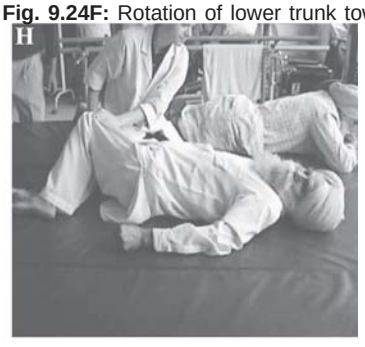


Fig. 9.24F: Rotation of lower trunk towards right





Figs 9.24G and H: Combined movements of rotation of neck, shoulder and lower trunk to add complexity

Fig. 9.24: Rotation of neck, trunk and upper extremity

ii. Movements should be started first in distal joints and then progression can be made for more proximal joints. This is because trunk and other proximal muscles are more involved than the distal muscles.
iii. Movements performed should be large, simple and through the full range.
iv. Rhythm or music may facilitate the movement.
v. It is easier to perform the movements in bilateral symmetrical patterns rather than reciprocal patterns. For example, arm swinging.
vi. Progression may be made by performing movements in diagonal pattern.
vii. Stress, fatigue, anxiety or need to hurry may exacerbate the freezing associated with PD.[20]

- *Breathing exercises*: As the patients of PD adopt a more flexed posture, the chest expansion is reduced. Moreover, the most common cause of death in these patients is pneumonia. Thus, breathing exercises are very important and should be incorporated at all stages of PD to maintain vital capacities and prevent pulmonary complications. The exercise may range from simple chest expansion exercise to specific breathing exercise.
- *Strengthening exercises*: Muscular weakness is not the main feature of PD. However, strength may be decreased due to disuse. Hence, strengthening exercises should be included in the treatment program of PD. In addition to it, strengthening exercises may help to prevent falling. Physical therapist should remember that functional strength training is more effective than weightlifting in improving muscular strength in the patients of PD.[38] Special attention should be paid to extensors of trunk so as to counteract the flexed posture that develops in these patients.
- *Mobilization techniques*: There is a tendency to have the limitations in the range of ankle dorsiflexion, knee flexion and extension, hip extension, spine extension and rotation of trunk as well as both extremities. Hence, mobilization techniques are essential for the patients of PD to improve ROM. However, it should be remembered that conditions such as osteoporosis may results into an injury, if vigorous mobilization is done.
- *Aerobic exercise*: The patients of PD can participate in aerobic exercise without increasing the disease activity. However, as far as the intensity of exercise is concerned, it is reported that vigorous aerobic exercise is beneficial in the earlier stages, whereas a carefully structured low-impact aerobic exercise is beneficial for the patients who are in the later stages of disease. The benefits may include:
  i. Improvement in vital and aerobic capacities[34]
  ii. Improvement in immunological function[41]
  iii. Improvement in gait and balance[42]
  iv. Reduction in dysfunction[43]
- *Proprioceptive neuromuscular facilitation*: In PD, a dominance of flexor muscle group leads to an impairment of rotation because rotation is dependent upon balanced activity between flexor and extensor muscle groups. This suggests that technique of PNF, in which rotatory component acts as the holding or stabilizing group, should be used in these patients. In "normal timing" rotation initiates the movement, giving stability and direction to the pattern. Following this, movement takes place at the distal joints.[56] This sequence is particularly

helpful because, as discussed earlier, proximal muscles are more involved than distal muscles in Parkinson's disease. All patterns of PNF should be administered, but trunk patterns are the essential movements as trunk rotation helps in reducing proximal rigidity.[36] Fig. 9.25 shows the use of symmetrical PNF pattern to take off the shirt by the patient himself.

- *Postural correction*: Patients with PD may have a more flexed posture both due to the CNS pathology and the ageing process. Thus, postural correction should be directed towards the attainment of an extended, upright posture. The following techniques may be used:
  i. McKenzie's technique
  ii. Passive stretching of flexor muscle groups
  iii. Strengthening of extensor muscle groups
- *Balance training*: This should be started at the early stage of the disease. The training should include
  i. Self-induced displacements
  ii. External displacements
  iii. Equilibrium reactions at various speeds and in all directions
  iv. A variety of task-specific activities

However, in the technique of rhythmic stabilization, the direction of resistance should be changed gradually. This is to allow sufficient time so as to develop force in one set of muscles before switching over to other set of muscles. Physical therapist must remember that if proper timing is not allowed to a patient of PD, the already inefficient, ineffective patterns of motor activity may be reinforced.

- *Transfer training*: This is one of the major problems with the patients of PD. Because transfer activity is the complex task and primary problem of these patients is the difficulty

Fig. 9.25: Taking off the shirt while using symmetrical PNF pattern of arms

in motor planning. Thus, to make it easier to perform these tasks, physical therapist should train them on the basis of following guidelines:

i. The complex task should be broken down into simple components
ii. Rolling over in bed should include trunk rotation
iii. To get out of the bed, patient should learn to roll onto one side and then to lower the hips off the bed
iv. Lateral and anerior/posterior tilts in sitting position should be practiced first to facilitate the functional task of standing from sitting
v. The warmth of an electric mattress will reduce the need of covers, which in turn, may make the bed mobility easier
vi. Satin sheets with satin dress will also make the bed mobility easier
vii. The verbal and physical cuing may provide guidance to patient
viii. In later stages when mobility becomes very difficult, the assistance may be provided manually by the care-taker or with the help of bed rails, a lift chain or a commode with arms.

- *Gait training*: Physical therapist should design a comprehensive gait training program so as to reduce the main problems of gait such as lack of rotation, loss of arm swing, "freezing" and small steps. Thus, the program may include:
  i. The movement of rotation of upper trunk, lower trunk and upper extremity. Examples of such movements are displayed in Fig. 9.24.
  ii. Rhythmical alternate movements of arm flexion and extension. This may be done in sitting to initiate arm swing (Fig. 9.26).
  iii. Exercises that can improve extension and reduce flexed posture. This is to superimpose arm swing in an automatic manner. Because even in normal individuals, arm swing which is a passive action occurs as a result of interaction between the pelvis and shoulder girdles on the basis of an extended upright posture.
  iv. Auditory stimulation. Use of appropriately synthesized music during walk may improve stride length and speed.[39]
  v. Visual stimulation. This can be provided by asking the patient to walk on the parallel lines drawn on the floor with a gap in between (Fig. 9.27) which may help to cope with freezing episodes.[40]
  vi. No assistive device. This is because at times, it may increases a festinating gait.
  vii. Progression. This may be made by gait training
    – on steps
    – in crowds
    – through doorsteps
    – with different speeds and
    – with different stride lengths
- *Surgical therapy*:
  – *Pallidotomy*: The surgical destruction of globus pallidus is helpful in relieving the contralateral drug-induced dyskinesias in most of the patients.
  – *Deep brain stimulation*: Deep brain stimulation of globus pallidus may be effective in improving the motor symptoms of PD.

Fig. 9.26: Arm swinging in sitting

Fig. 9.27: Parallel lines drawn on the floor provides visual stimulation

PERIPHERAL NEUROPATHY

Disorders of peripheral nerves are regularly encountered in the elderly. It is estimated that 18 percent of Caucasian Americans and 26 percent of African-Americans older than 60 have diabetes mellitus; half of these people have peripheral neuropathy. Thus, approximately 10 percent of Americans over 60 have peripheral neuropathy due to diabetes and another 10 percent have peripheral neuropathy due to other causes, which suggests that 20 percent of elderly American population is suffering from peripheral neuropathy.[55] Peripheral neuropathy due to diabetes is discussed in chapter X.

To Summarize

Physical therapy is a mainstay in the management of neurological diseases and to get the best results, it should be started in the earlier stages of disease. Therapist should possess the basic knowledge of neurosciences and look toward the new and innovative ways to improve quality of neurologically impaired patients.

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10 Diabetes in Elderly

- **Definition and Classification**
- **Prevalence**
- **Risk Factors**
- **Clinical Features**
- **Diagnostic Criteria**
- **Additional Laboratory Findings**
- **Management**
- **Mortality Rate**
- **Diabetic Complications**

DEFINITION AND CLASSIFICATION[1]

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both.

Type I: Caused by an absolute deficiency of insulin secretion

Type II: Caused by a combination of resistance to insulin action and an inadequate compensatory insulin secretory response

Table 10.1 describes the difference between type I and type II Diabetes mellitus.

PREVALENCE

Diabetes mellitus (DM) is a prevalent disease, especially among the elderly. Approximately 20 percent of US population over age 65 years has DM. Half of these people may be unaware that they have DM. The prevalence seems to decline slightly in those older than 75 compared with those 65-74 years old and decreases further in those older than 85 years.[2]

RISK FACTORS

- Obesity
- Lack of physical inactivity
- Loss of muscle mass
- Hyperlipidemia
- Hypertension

CLINICAL FEATURES

- The classic symptoms of DM polyuria, polydipsia and polyphagia are usually present if fasting plasma glucose (FPG) > 200 mg/dL, but may be present at lower FPG levels, too.
- Unexplained weight loss
- Fatigue
- Blurred vision
- Dry mouth and tongue
- Symptoms of chronic infection, especially of the genitourinary tract, skin or mouth
- DM in elderly is associated with impaired cognitive function which correlates with glucose control
- In some patients, retinopathy or neuropathy may be the first presentation.

Table 10.1: Difference between type I and type II diabetes mellitus

Characteristics	*Type I*	*Type II*
% of diabetics	2-5 %	90-95 %
Age of onset	< 35-40 years	> 35-40 years
Type of onset	Abrupt	Insidious
Symptoms at onset	Often in ketoacidosis	Many times asymptomatic
Physical appearance	Thin or normal	80 % are obese
Insulin requirement	In all cases	In 25 % of cases
Ketonuria	Yes	No
Autoantibodies	Yes	No
Diabetic complications	Found usually after 5 or more years of onset of disease	Frequent
Genetic susceptibility	HLA-related DR3, DR4 and others	Genetic background not HLA related
Other autoimmune disease	Yes	Uncommon

DIAGNOSTIC CRITERIA

- FPG > 126 mg/dL
- A random plasma glucose > 200 mg/dL with classic diabetic symptoms
- 2 h plasma glucose > 200 mg/dL during an oral glucose tolerance test (OGTT)
- Diagnosis should be confirmed by reevaluating on a subsequent day
- Impaired glucose metabolism is considered to exist when FPG >110 and < 126 mg/dL or 2 h plasma glucose > 140 and < 200 mg/dL during an OGTT. However, this does not meet the diagnostic criteria for diabetes.

ADDITIONAL LABORATORY FINDINGS

- In addition to hyperglycemia, hyponatremia, findings of dehydration; and hypomagnesemia and hypokalemia.
- Glycated hemoglobin should be considered as a baseline value. However, it is not sufficiently sensitive to make a diagnosis of DM.
- *Lipid profile*:
  - Total cholesterol is commonly elevated
  - Usually there is increased triglyceride concentration with low levels of HDL cholesterol
  - LDL cholesterol may or may not be elevated.

MANAGEMENT

- *Principles of management* are similar for both young and elderly patients. However, considerations should be given to following points while managing the disorder in elderly.
  - Factors such as life expectancy, presence of other chronic disorders, functional status, taste perception and social environment strongly influence the goals of management of diabetes in elderly.
  - The elderly diabetics have reduced symptomatic awareness of hypoglycemia and limited knowledge of symptoms, and are at greater risk for hypoglycemia. However, they can be taught to monitor for and treat hypoglycemia appropriately.
  - The optimal degree of glycemic control in elderly has yet to be determined.
  - In addition, frequent hospitalizations of older patients may disrupt the OPD routine.
- *Pharmacological management*:
  - *Type I*: All patients require insulin therapy. It is administered subcutaneously by using glass syringe, plastic syringe, pen device or infusion pump. The commonest and simplest choice of insulin regimen is two injections/day of short-acting and intermediate-acting insulin, given in combination before breakfast and the evening meal.
  - *Type II*: Pharmacological management given to these patients is either oral medication or insulin. Oral medications include sulphonylurea medications usually for non-obese patients, whereas metformin is prescibed to obese patients. Combined therapy such as sulphonylurea + metformin is also used. If diabetes is not controlled with oral medications, insulin therapy, usually in large doses is recommended.
- *Non-pharmacological management*:
  - Comprehensive education of patient and family, especially in newly diagnosed case of DM
  - Alcohol and smoking cessation
  - Healthy diet
  - Regular exercise
  - Self-monitoring of blood glucose
  - No physical or emotional stress
- *Diet*: Diet control is essential in all types of diabetes. Two types of diet are used to achieve the ultimate goal of management, i.e. normal metabolism:
  - *Low-energy, weight-reducing diets*: Diet that causes a daily deficit of 500 kcal is essential for obese diabetic patients. However, this may lead to loss of lean body mass, particularly

in elderly individuals. Therefore, diet restriction should be combined with exercise therapy. In addition, the diet should include nutrients, vitamins and minerals in sufficient amount.
  - Weight maintenance diets: This is recommended for non-obese patients. Such type of diet should be high in carbohydrate and low in fat.
- *Exercise*: A regular exercise program of moderate intensity reduces the requirements for insulin or oral medication in patients with DM. The possible mechanisms are increased glucose use by muscle and improved muscle sensitivity to insulin. However, these metabolic effects of exercise can increase risk of hypoglycemia. Thus, exercise does not always improve the glucose control. Hence, the exercise program should be tailored individually. There should be a combination of exercise in weight-bearing and non-weight bearing positions. Nevertheless, 80 percent of exercise duration should be spent in non-weight bearing position to avoid undue stress on the degenerative joints of elderly, e.g. swimming or cycling. In addition, following precautions should be observed during exercise in diabetics.
  - The first step is to increase glucose monitoring during exercise, especially for patients on insulin or oral medications.
  - At the beginning of an exercise program, particularly with type I diabetic patients, glucose levels should be checked prior to exercise, every 15 to 30 min during exercise and after stopping exercise. A final blood glucose check should be performed approximately 4 to 5 hrs later to know the fall in glucose levels.
  - Type I diabetics should not exercise during insulin insufficiency, as it may promote a hyperglycemic response and increase the risk for metabolic acidosis. This is because ketosis is very common in type I diabetics exhibiting a higher secretion of glucagons and catecholamines during exercise. In fact the secretion of catecholamines during exercise is so great that release of glucose from the liver exceeds the rate of consumption by muscle. Thus, additional insulin may have to be given and exercise should be stopped if the glucose level is higher than 250 mg/dL or if ketones are present in the urine.
  - The upper value for deferring exercise in type II diabetics is higher than type I diabetics, i.e. 300 mg/dL because ketosis is uncommon and also unlikely to be provoked by exercise in type II diabetics.
  - Before starting an exercise program, the diabetic elderly should be evaluated thoroughly to reveal the presence of co-morbidity or any diabetic complication. The following strategies should be considered to avoid any kind of harm to the diabetic elderly:
    1. *Hypoglycemia*: Exercise should be done 45-60 min after eating. Dietary intake is increased as displayed in Table 10.2 and sugar supplements should be kept handy. Remember that hypoglycemia may occur for up to 24 hrs after exercising.
    2. *Insulin levels*: Exercise should be done 1 hr after insulin injections. Glucose should be monitored carefully and exercise should be avoided during peak insulin activity. Caution should be observed when injecting insulin over exercising muscle, because insulin injected this way is absorbed more quickly and translated into more potent glucose-lowering effects.
    3. *Cardiovascular problems*: Remember that vital signs may not be an accurate indicator of exercise tolerance. In general, exercise should be stopped if patient feels dizziness, excessive shortness of breath, nausea or chest pain.

4. *Proliferative retinopathy*: Systolic BP should not be > 170 mm Hg during exercise. Isometrics, Valsalva maneuvers and head-jarring should be avoided.
5. *Autonomic nervous system dysfunction*: Physical therapist should keep a strict watch for orthotic hypotension, anginal pain, distal anhidrosis and poor heat compensation. Pulse should be monitored during and after exercise.
6. *End-stage renal disease*: Patient should be sufficiently hydrated and systolic BP should not be > 170 mm Hg during exercise.
7. *Peripheral neuropathy*: Patient should use proper footwear during exercise. Repetitive stresses should be avoided and distal extremities should be examined carefully.

Table 10.2: Dietary strategy for exercising diabetics

Blood glucose level (Before the start of exercise)	*Duration and intensity of exercise*	*Carbohydrate exchanges**
<130 mg/dL	35-40 min< 60% of VO_2 max	Two
<130 mg/dL	35-40 min> 70% of VO_2 max	Three
<130 and >180 mg/dL	35-40 min< 60% of VO_2 max	One
<130 and >180 mg/dL	35-40 min> 70% of VO_2 max	Two
<180 and >240 mg/dL	35-40 minmild to intense	No
> 250 mg/dL	Exercise is not recommended till blood glucose level is brought back to the safety limits	—

*One carbohydrate exchange = 60 kcal

MORTALITY RATE

Mortality rate among the elderly diabetics is more than double that of age-matched non-diabetic individuals, largely because of increased deaths from cardiovascular disease.

DIABETIC COMPLICATIONS

- *Acute complications*: (Table 10.3)
  - Hypoglycemia
  - Diabetic ketoacidosis
  - Non-ketotic hyperosmolar diabetic coma
- *Chronic complications*:
  - Microvascular complications: neuropathy, retinopathy and nephropathy
  - Macrovascular complications: cardiovascular disease

Table 10.3: Acute diabetic complications

Characteristics	*Hypoglycemia*	*Diabetic ketoacidosis*	*Non-ketotic hyperosmolar diabetic coma*
Commonly found in	Both type I and II	Type I	Type II
Blood glucose level	< 70-80 mg/dL	> 300 mg/dL	> 600 mg/dL
Cause	Too much insulin or oral medications; insufficient food intake, increased physical activity	Lack of insulin action in presence of glucagons	Osmotic diuresis caused by hyperglycemia and consequent dehydration

Contd...

Contd...

Characteristics	*Hypoglycemia*	*Diabetic ketoacidosis*	*Non-ketotic hyperosmolar diabetic coma*
Predisposing factors	Alcohol, lipohypertrophy, malabsorption, gastro-paresis due to autonomic neuropathy	Infection, stroke, myocardial infarction, missed insulin doses	Dementia, infection, stroke, myocardial infarction
Mortality rate	2-4% in insulin-treated patients	5-10% in average, higher in elderly	Usually affects elderly with mortality rate over 40%
Hydration	Unchanged	Increased thirst, polyuria dehydration	Rapid volume depletion with increased thirst, initial polyuria progressing to decreased urine output
Metabolic acidosis	Not present	Not present	Elevated serum acetone, Ketone bodies in urine
Onset	Abrupt	Gradual	Gradual
Common symptoms	Sweating, hunger, trembling, pounding heart, anxiety. Confusion, slurred speech, drowsiness. Nausea, headache, tiredness.	Weight loss, weakness, leg cramps, blurred vision, abdominal pain, nausea, vomiting, rapid deep breathing, headache, confusion, drowsiness, coma.	Abdominal pain, confusion, coma
Skin	Clammy, diaphoretic	Hot, dry	Warm
Treatment	Oral carbohydrate or IV administration of either glucose or glucagons, if patient is not able to swallow. Identification and treatment of precipitating cause	Short-acting insulin, fluid replacement, potassium replacement management of precipitating factor	Fluids as 0.45% saline until the osmolality approaches normal, after which 0.9% is substituted, insulin, check for plasma sodium concentration, management of precipitating factor

Neuropathy

- Relatively early and common diabetic complication
- Affects approximately 30 percent patients
- Occurs secondary to metabolic disturbances
- It may lead to severe disability. However, in most cases is symptomless
- It include focal neuropathies, polyneuropathy and autonomic neuropathy
- Sensory loss is more prevalent than motor loss
- Focal neuropathies include entrapment syndromes and mononeuropathies
- The most common entrapment syndrome is carpal tunnel syndrome
- The ulnar nerve and nerves of the feet may also be involved with entrapment syndromes, but they are of slow onset and persist until treated
- Focal neuropathy may affect a single peripheral or cranial nerve
- These mononeuropathies are severe and of rapid onset, usually caused by vasculitis and subsequent ischemia.

- The most commonly affected nerves are 3rd and 6th cranial nerves resulting in diplopia. But thoracic and peripheral nerves may also be involved as well
- Physical therapy may be necessary, but the neuropathy usually resolves spontaneously.
- Proximal motor neuropathy, also known as "diabetic amyotrophy" primarily affects elderly patients. This begins with pain, mainly felt on anterior aspect of thigh on one side and then involes other side and progresses to proximal muscle weakness and wasting sometimes there may be weight loss, condition known as "neuropathic cachexia". Management is mainly supportive.
- Symmetrical sensory polyneuropathy is frequently asymptomatic. On examination, there is decreased perception of vibration sensation distally, loss of tendon reflexes and loss of all sensations in a stocking/glove pattern. Symptoms include paresthesia commonly in feet and rarely in hands, pain in lower limbs, burning sensation in sole of feet and abnormal gait. Muscle weakness and wasting develops in later stage which results into clawing of toes. This further leads to development of callus and pressure points, particularly under the metatarsal heads.
- Patients with distal sensory polyneuropathy are predisposed to Charcot joints and foot ulcer, too.
- Advice to these patients to reduce risk for foot ulceration is displayed in Table 10.4.
- Autonomic neuropathy affects sympathetic and parasympathetic nervous system of 20-40 percent patients with long-term diabetes. Clinical features of autonomic neuropathy are described in Table 10.5.

Table 10.4: Advice to patients with distal sensory polyneuropathy to reduce risk for foot ulceration

• Do not walk barefoot
• Test the water temperature with elbow
• Inspect your feet daily
• Use nonweight-bearing type of exercise such as cycling or swimming rather than walking
• Prefer loose cotton socks instead of tight nylon ones
• Use proper footwear with orthotics

Retinopathy

- Diabetic retinopathy is the most common cause of blindness in the United States.
- Duration of DM is the major predictor of risk for retinopathy with ischemia being the main culprit.
- The characteristic clinical features of diabetic retinopathy include microaneurysms, retinal hemorrhages, exudates, cotton wool spots, pre-retinal hemorrhage and fibrosis.
- Classification includes nonproliferative disease, proliferative disease and proliferative retinopathy.
- Treatment: Photocoagulation is used to destroy areas of retinal ischemia, to seal micro-aneurysms and reduce macular edema. Vitrectomy may be undertaken if neovascularization leads to vitreous hemorrhage or if retinal detachment occurs.
- As a caution isometrics, Valsalva maneuvers and head-jarring exercises should be avoided and systolic BP should be kept below 170 mm Hg during exercise.

Table 10.5: Clinical features of autonomic neuropathy

Physiological system	*Clinical features*
Cardiovascular	*Postural hypotension*: A sharp fall in BP in response to postural change causing faintness
	Fixed heart rate: No rise or fall in HR in response to normal body functions or exercise
Gastrointestinal	*Constipation*: results from colonic atony
	Dysphagia: results from esophageal atony
	Gastroparesis: causing nausea, vomiting, distention, loss of desire to eat and unstable diabetes
Genitourinary	*Urinary tract dysfunction*: Inability to evacuate bladder completely, urinary incontinence, recurrent infection due to atonic bladder.
	Decreased sexual response: Impotence in men, difficulty with lubrication, arousal or orgasm in women
Sudomotor	*Nocturnal sweats*: Profuse sweating at night
	Gustatory sweating: Profuse sweating while eating
	Anhidrosis: Deficient sweat secretion
Pupillary	*Decreased response to light*
	Decreased pupil size
Vasomotor	*Feet feel cold*: due to reduced skin vasomotor response
	Dependent edema: due to loss of vasomotor tone and increased vascular permeability.

Nephropathy

- Elderly diabetics are at a particular risk for nephropathy.
- It begins with microalbuminuria that progresses to overt proteinuria to renal insufficiency and ultimately to end-stage renal disease.
- Typically the duration of progression is 10-20 years in younger population. However, in elderly diabetics the course is much shorter.
- Improved control of blood glucose, reduction of blood pressure and administration of angiotensin-converting enzyme (ACE) inhibitors can reduce the risk for progression of diabetic nephropathy.
- There is no evidence establishing the direct link between exercise and progression of diabetic neuropathy. It is still advised to have a close monitoring of BP, as hypertension is known to be the aggravating factor.
- Rescheduling of exercise therapy should be considered for the patients on dialysis therapy
- Physical therapists should provide guarding against skin injury caused by weights or hand placement, particularly for patients using anticoagulants.

Cardiovascular disease: There is 2-fold increase in risk for coronary heart disease in diabetic patients.[2] Hyperglycemia is often found in patients who have sustained an acute myocardial infarction. Strict glycemic control and aggressive control of hypertension are beneficial to reduce the risk for cardiovascular disease. Aspirin therapy has also been shown to be beneficial in secondary prevention of coronary heart disease. Role of exercise.

To Summarize

Diabetes mellitus is a common chronic disorder of elderly that includes multisystem involvement. A team approach is essential to improve glycemic control, adherence to therapy and thus, quality of life.

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11 Cognitive Deficits and Dementia in Elderly

- Introduction
- Definition and Description of Key Terms
- Prevalence
- Causes of Dementia
- Clinical Features
- Evaluation and Assessment
- Management

INTRODUCTION

Cognitive deficits are commonly found in elderly individuals. The patient with cognitive deficits may need to learn basic functional skills. Physical therapist can explore the ways to compensate for the changes in cognitive function and the patient may achieve the potential for self-care and meaningful life activities. Therapeutic intervention may include consultation and training for caregivers and the modification of therapeutic techniques for patients with cognitive impairments. For example, functional training, neurological rehabilitation focusing on kinesthetic cuing, environmental adaptations and modifying communication abilities and simplifying ADL and IADL tasks.

DEFINITION AND DESCRIPTION OF KEY TERMS

Physical therapist working with patients with cognitive deficits needs to have adequate knowledge so as to differentiate between the changes that occur in cognitive function due to aging and the cognitive impairments that occur with a specific illness. Definition and description of following terms will be helpful to understand this difference:

- *Age-related changes in cognitive function*: With normal aging there may be some changes in cognitive function. Memory loss is one of the most important cognitive components associated

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with aging. The older person may exhibits subjective problems such as difficulty in recalling names or where an object was placed. However, the characteristic feature of age-related memory loss is that older person recalls with cues or remembers the information later. Any deficits in memory function are subtle, stable over time and do not cause functional impairment. Compared with younger adults, older adults perform more slowly on timed tasks and have slower reaction times. Nevertheless the learning capacity usually remains intact.

- *Delirium*: Delirium is an acute disorder of attention and cognitive function that may arise at any point in the course of an illness.[5]

A person with delirium usually shows a change both in intellectual function and in level of consciousness.[1] There are three forms of delirium:

1. Hyperactive, hyperalert form
2. Hypoactive, hypoalert, lethargic form
3. Mixed form that combines both forms

- *Dementia*: Dementia can be defined as an acquired decline in memory and in at least one other cognitive function (e.g. language, visual spatial, executive function) sufficient to affect daily life in an alert person.[2]

  Dementia is most severe type of cognitive impairment with gradual onset and continuing decline. It often goes undiagnosed in primary care settings, particularly in the early course of disease. Therefore, early diagnosis is imperative to determine the cause or causes to execute appropriate and effective treatment plan.
- *Alzheimer's disease*: Alzheimer's disease (AD) is a degenerative disease of the brain of unknown cause.[3]

The term Alzheimer's disease is not synonymous with dementia but rather one of the many causes of dementia. According to clinical criteria published by McKhann and colleagues,[4] there is typical insidious onset of progressive dementia, not caused by any other disease known to produce memory loss and cognitive decline.

PREVALENCE

The prevalence of dementia almost doubles every five years in elderly. In America, the prevalence is estimated to be 25-45 percent among community-dwelling elders and still higher, i.e. >50 percent in nursing homes.[5] The population projections suggest that this number will be increased by five times by the year 2040.

CAUSES OF DEMENTIA

- Alzheimer's disease accounts for 60-70 percent cases of dementia.
- Correctable conditions such as drug complications, infectious diseases, metabolic and nutritional disorders, subdural hematoma, normal-pressure hydrocephalus and thyroid dysfunction accounts for 2-5 percent cases of dementia. This is known as reversible dementia.
- Progressive disorders such as vascular and Lewy bodies accounts for 15-30 percent cases of dementia.

CLINICAL FEATURES

Stages of Alzheimer's Disease

Preclinical

- Delayed paragraph recall
- Frequent repetitions of the same questions or stories
- No functional impairment
- Mild construction, language or executive dysfunction

Early Stage (Between 1 and 3 years from onset of symptoms)

- Slow reactions
- Sluggishness in picking up new information
- Disorientation for date
- Naming difficulties
- Recent recall problems
- Mild difficulty copying figures
- Missed appointments
- Decreased insight
- Reduced participation in social functions
- Getting lost
- Heightened anxiety
- Difficulty handling finances

Middle Stage (Between 2 and 8 years from onset of symptoms)

- Disorientation to date, place
- Trouble recognizing familiar people
- Illegible writing
- Impaired calculating skills
- Late afternoon restlessness (sundown syndrome)
- Difficulty with perceptual motor coordination
- Impulsive actions
- Loss of ADL skills
- Self-neglect
- Repetitive physical movements
- Overreaction to minor events
- Delusions, agitation, aggression

Late Stage (Between 6 and 12 years from onset of symptoms)

- Nearly incomprehensible verbal output
- Loss of remote memory
- Inability to recognize self or family members
- Incontinent

- Reduced ability to walk or get around
- No longer grooming or dressing
- Motor or verbal agitation

Vascular Dementia

- Sudden onset of dementia after a stroke or stepwise decline rather than continuous
- Focal neurological findings
- Behavioral and psychological problems same as AD
- Less severe memory impairments and recall problems than AD
- More severe depression than AD.

Dementia with Lewy Bodies

- Parkinsonism that is manifested primarily by rigidity and bradykinesia rather than tremor
- Although there is fluctuation in cognitive impairment, onset is insidious and nature of disease is progressive similar to AD.
- Visual hallucinations are more commonly found than AD
- Sensitivity to antipsychotic medications suggest that caution should be exercised while using these medications.

Frontotemporal Dementia

- Develops at a relatively young age
- Early changes in personality and behavior with relative sparing of memory
- Hyperorality that may be manifested by marked changes in preferring the type of food
- Executive dysfunction
- Primary progressive aphasia
- Sparing of visuospatial abilities

EVALUATION AND ASSESSMENT

- *History*
  - *Duration of symptoms*: "Since how long the symptoms have been present?"
  - *Type of onset*: "Whether the symptoms started gradually or suddenly?"
  - *Rate and nature of decline in cognitive function*: "Whether the decline was stepwise or continuous?"
  - *Social history may help to assess recent memory*: For example, "How often do you visit your uncle?"
  - *Medical history may give idea about remote memory*: For example, "Were you operated for fractured femur?"
  - *Drug history*: Use of prescription, over-the-counter and illegal drugs, alcohol, caffeine and nicotine.
  - *Language problems*: This can be primarily assessed while talking to patient.
  - Family members or caregivers should be involved to obtain complete information.
- *Physical and neurological examination*: This will help to identify the secondary cause of cognitive dysfunction:

  - *Neuromuscular examination*: The presence of rigidity, bradykinesia and tremor indicates dementia with Lewy bodies.
  - *Sensory examination*: There may be disturbances in visual acuity, depth perception, color differentiation of figure from ground.[6,7]
  - *Gait and balance*: Modified performance-oriented mobility assessment (POMA) is used for the assessment of balance and gait (Appendix-III).
  - *Reflexes*: Exaggerated reflexes may indicate the presence of hypertonicity. However, it should be remembered that increased tone and brisk reflexes can be nonspecific in the later stage of dementia in elderly.
  - *Postural assessment*: Elderly patients with dementia are usually found to be in sitting position with feet unsupported and hips flexed, head forward, hands resting unnaturally.
  - *Cardiovascular examination*: This is important to confirm the diagnosis of vascular dementia.
- *Assessment of functional status*:
  - ADL: Appendix-I
  - IADL: Appendix-II
- *Mental state*:
  - The Mini-Cog assessment instrument is briefer and has reasonable test characteristics to indicate the presence of dementia (Appendix-IV).
  - Geriatric depression scale (GDS) is used to assess the level of depression in elderly (Appendix-V). Higher the score on GDS, greater is the severity of depression. The presence of depression should be detected as early as possible in elderly patients with dementia for following reasons:
    - Depression can be misdiagnosed as dementia in many older patients.
    - Depression may have negative impact on motivation of elderly.
    - Therapeutic intervention may have to be modified in the presence of depression.
- *Laboratory testing*: Liver and renal function tests, serum calcium, electrolytes, CBC, TSH may be recommended to find out secondary cause or comorbid conditions in patients with dementia.
- *Neuroimaging*: CT scan or MRI scan are not considered as routine tests in elderly with dementia. However, they may be used in young patients with abrupt onset or rapid decline or to rule out the secondary cause of dementia such as subdural hematoma or normal-pressure hydrocephalus.

MANAGEMENT

Aims of Treatment

- To identify and treat secondary cause
- To maintain and maximize function
- To improve the efficiency of learning
- To improve quality of life.

Pharmacological Treatment

- *Cholinesterase inhibitors*: Cholinesterase inhibitors have been shown to improve cognitive function probably by increasing level of acetylcholine in brain. At present, FDA has approved four drugs for the treatment of mild to moderate AD:

- Donepezil
- Rivastigmine
- Galantamine
- Tacrine

Environmental Modifications

Music during meals, bathing, Simulate family member's presence with video or audio tapes

- Good, nonglare lighting
- Quiet room with no distractions such as background noise
- Dark and clear large-sized print
- Low-vision aids such as magnifying glass
- A systematic storage of clothes and toilet articles
- Contrasting colors for identifying doors, windows, cupboards and corners

Improving the Efficiency of Learning

- The time given for learning or relearning should be as much as elderly patients want because elderly persons with or without dementia perform best when learning is self-paced rather than fast-paced.

Advice to Caregivers

- Explain the importance of touch as the means of communication.
- Try to know about the interests of patient such as hobby, favorite game or favorite food.
- Use the way of communication that patient enjoys most.
- Avoid the activity that patient does not like to participate in.

Communication Skills

The strategies to enhance communication can be:

- Verbal orientation
- Guided touch
- Directional movement
- Body language

Behavior Modifications

- Physical therapist should know what has been creating comfort to the patient in the past.
- It should be remembered that elderly patients with dementia may function well in a familiar environment. However, they may not be able to perform their ADL and even become severely disoriented in a new environment (transplantation shock).
- All changes, may it be in environment or treatment regimen, should be carefully planned. For example, informing the patient repeatedly about the kind of change to be made, arranging one or two trial visits before actual move from one location to another.
- Patient should be involved in decision making.

Physiotherapy

- The first step is to create a sense of safety and comfort.
- *Massage*: Light massage may help to enhance comfort and relaxation.
- *Breathing exercises*: In general, elderly patients with dementia have shallow breathing. Gentle tapping and touching procedures may improve the ventilation.[8]
- *Relaxation exercises*: Elderly patients with dementia usually show overall tension. Appropriate correction of posture: For example, patient is instructed to sit with feet supported, hands on arm rest or in the lap with the wrists in neutral position.
- Lumbar support may be provided to increase comfort while sitting for longer duration.
- Passive therapeutic techniques in the beginning of treatment, particularly if patient is very tense.
- *Active participation*: A simple set of active exercises should be used in the beginning of treatment session in order to verify the pshychomotor readiness to participate.
- *PNF techniques*: The touch, pressure, distraction and resistance applied by physical therapist help to stimulate neuromuscular response. These techniques are used to reinforce improvement in functional activities of elderly patients with dementia.

Movement Therapy Approaches

- *Feldenkrais method*: The mainstay of Feldenkrais method is that people can change and all people can learn. Movement is the medium by which one learns, essentially, how to learn. The method has two components:
  1. *Awareness through movement (ATM)*: ATM is verbally directed movement lessons. In a one-year follow-up study responses to ATM were a greater ease of movement, better functional balance, enhanced mental outlook and improved quality of life.[9]
  2. *Functional integration (FI)*: FI is one-on-one hands-on nonverbal dialogue related to movement awareness and options.
- *Tai chi*: Tai chi is an exercise form that allows the individual to assume an active role recognizing the mind-body interaction. Many forms of Tai chi exercise are available, involving 108 postures and transitions of controlled movement.[10] It has cardiovascular, neuromuscular and psychological benefits.[11-13] Tai chi exercise is especially important in elderly people because of its slow, controlled, non-impact and graceful nature of movement.

To Summarize

The role of physical therapy is most challenging and deeply rewarding in working with cognitively impaired patients. However, it needs the effective and timely assessment; the creation of a therapeutic environment; training and education to caregivers; and modifications of treatment program including movement therapy approaches.

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APPENDICES

Appendix I
Activities of Daily Livings (ADLs)

A. Toilet
- **I:** Able to get to, on and off toilet, cleans self
- **A:** Needs help getting to and using toilet, soiling or wetting while asleep more than once a week
- **D:** Completely unable to use toilet

B. Feeding
- **I:** Able to completely feed self
- **A:** Feeds self with assistance and is untidy
- **D:** Completely unable to feed self or needs parenteral feeding

C. Dressing
- **I:** Able to select clothes, dress and undress self
- **A:** Needs assistance in dressing and selection of clothes
- **D:** Completely unable to dress and undress self

D. Grooming (neatness, hair, nails, hands, face, clothing)
- **I:** Able to groom well without assistance
- **A:** Needs assistance for grooming
- **D:** Completely unable to care for appearance

E. Physical Ambulation
- **I:** Able to get in/out of bed, roam around without help
- **A:** Needs human or mechanical (crutch, walker, cane) assistance
- **D:** Completely unable to get in/out of bed/chair, walk

F. Bathing
- **I:** Able to bathe (tub, shower or sponge) without assistance
- **A:** Needs assistance for getting in and out of tub or washing more than 1 body part
- **D:** Completely unable to bathe self

Directions:

I – Independent
A – Requires assistance
D – Dependent

Source: Singh S, Multani N K, Verma S K: Development and validation of geriatric assessment tools: a preliminary report from Indian population. JESP, 2007, Vol. 3, No. 2.

Appendix II
Instrumental Activities of Daily Livings (IADLs)

A. Ability to use telephone
- **I:** Able to operate telephone on own initiative, look up numbers, dial and receive without help
- **A:** Answers telephone but needs special phone or assistance in getting number, dialing
- **D:** Unable to use telephone at all

B. Shopping
- **I:** Able to take care of all shopping needs independently
- **A:** Able to shop but needs to be accompanied on any shopping trip
- **D:** Unable to shop

C. Preparing meals
- **I:** Able to plan and prepare meals independently
- **A:** Unable to cook full meals alone
- **D:** Unable to prepare any meals

D. Housekeeping
- **I:** Able to maintain house independently, e.g. scrubbing the floor
- **A:** Able to do light housework but needs assistance with heavy tasks
- **D:** Unable to do any housework

E. Laundry
- **I:** Able to launder independently
- **A:** Launders small items such as socks, handkerchiefs
- **D:** Unable to launder at all

F. Traveling
- **I:** Able to drive own car or travels independently on public transportation
- **A:** Needs assistance for traveling
- **D:** Unable to travel

G. Responsibility for own medications
- **I:** Able to take medications in correct dose at the right time
- **A:** Able to take medications if it is prepared in advance in separate dosages
- **D:** Unable to take medications

H. Ability to manage finances
- **I:** Able to manage finances independently, e.g. write checks, pay bills
- **A:** Able to manages day-to-day purchases but needs assistance for banking or major purchases
- **D:** Unable to handle money

Directions:

I – Independent
A – Requires assistance
D - Dependent

Source: Singh S, Multani N K, Verma S K: Development and validation of geriatric assessment tools: a preliminary report from Indian population. JESP, 2007, Vol. 3, No. 2.

Appendix III
Modified Performance-Oriented Mobility Assessment (POMA)

BALANCE

Initial instructions: Subject is seated in hard, armless chair. The following maneuvers are tested.

1. **Sitting down**
   - 0 = misjudged distance, falls into chair or lands off center of chair
   - 1 = uses arms or not a smooth motion
   - 2 = sits in a smooth, safe motion and ends with buttocks against back of chair and thighs centered on chair
2. **Sitting balance**
   - 0 = leans or slides in chair
   - 1 = holds onto chair to keep upright
   - 2 = steady, safe, upright
3. **Arising**
   - 0 = unable without help or requires
   - 1 = able but uses arms to help to pull or push up; and or moves forward in chair before attempting to arise
   - 2 = able without using arms
4. **Attempts to arise**
   - 0 = more than 3 attempts required
   - 1 = more than 1 attempt required
   - 2 = single attempt
5. **Immediate standing balance (first 5 seconds)**
   - 0 = any sign of unsteadiness (swaggers, moves feet, marked trunk sway or grabs object for support)
   - 1 = steady but uses walker or other support but catches self without grabbing object
   - 2 = steady without walker or other support
6. **Standing balance (Romberg position)**
   - 0 = unsteady
   - 1 = steady but wide stance (medial heals > 4 inches apart) and uses cane or other support
   - 2 = steady, narrow stance without support for 10 seconds
7. **Eyes closed (Romberg position)**
   - 0 = any sign of unsteadiness or needs to hold onto an object
   - 1 = steady with feet apart
   - 2 = steady without holding onto any object with feet together
8. **Nudge on sternum** (patient standing with feet as close together as possible, examiner pushes with light even pressure over sternum 3 times)
   - 0 = begins to fall
   - 1 = needs to move feet, but able to maintain balance
   - 2 = steady, able to withstand pressure

9. **Semi-tandem stand (stand with the heel of one foot placed to the side of the big toe of the opposite foot for 10 seconds)**
   0 = unable to semi-tandem stand or begins to fall or holds for ≤ 3 seconds
   1 = able to semi-tandem stand for 4 to 9 seconds
   2 = able to semi-tandem stand for 10 seconds
10. **Full tandem stand**
   0 = unable to tandem stand or begins to fall or holds for ≤ 3 seconds
   1 = able to tandem stand for 4 to 9 seconds
   2 = able to tandem stand for 10 seconds
11. **Standing on one leg**
   0 = unable to stand or begins to fall or holds for < 3 seconds
   1 = able to stand for 3 to 4 seconds
   2 = able to stand for 5 seconds
12. **Reaching up (ask patient to remove an object from a shelf high enough to require stretching or standing on toes)**
   0 = unable or is unsteady
   1 = able to get object but needs to steady self by holding on to something for support
   2 = able to take down the object and is steady
13. **Heel stand**
   0 = unable to stand or begins to fall
   1 = able to stand for < 3 seconds
   2 = able to stand for 3 seconds
14. **Bending over (ask the patient to pick up a pen that is placed approximately 12 inches from the patient's foot on dominant side)**
   0 = unable or is unsteady
   1 = able, but needs more than one attempts to complete the task
   2 = able and is steady
15. **Turning balance 360°**
   0 = unsteady (grabs or staggers)
   1 = discontinuous steps (patient puts one foot completely on floor before raising other foot)
   2 = steady, continuous steps (turn is a flowing movement)

Balance Score: —/30

GAIT

Initial instructions: Subject stands with examiner, walks down 10-ft walkway (measured), first at "usual" pace, then turn and walk back at "rapid, but safe" pace. The subject should use customary walking aid.

16. **Initiation of gait** (immediately after told to "go")
   0 = any hesitancy or multiple attempts to start
   1 = no hesitancy
17. **Step height**
   0 = swing foot is not completely raised off floor
   1 = swing foot completely clears floor
18. **Step length**
   0 = swing foot does not pass the stance foot with step
   1 = swing foot passes the stance foot

19. Step symmetry
- 0 = right and left step length not equal,
- 1 = right and left step length appear equal

20. Step continuity
- 0 = places entire foot on floor before beginning to raise other foot or stops completely between steps
- 1 = begins raising heel of one foot as heel of other foot touches the floor, steps appear continue

21. Path deviation
- 0 = foot deviates from side to side or toward one direction
- 1 = foot follows close to straight line as subject advances

22. Trunk stability
- 0 = presence of marked trunk sway or flexion of knees or flexion of back or abduction of arms in an effort to maintain stability
- 1 = trunk does not sway, knees or back are not flexed, arms are not abducted in an effort to maintain stability

23. Walking stance
- 0 = feet apart with stepping
- 1 = feet should almost touch as one passes other

24. Turning (while walking)
- 0 = staggers, stops before initiating turn or steps are discontinuous
- 1 = no staggering, turning continuous with walking and steps are continuous while turning

Gait Score: —/ 9

Directions: Total score (Gait + Balance) = ——/ 39
"0" indicates the highest level of impairment.
Higher score indicates lower risk for falls.

Source: Singh S, Multani N K, Verma S K: Development and validation of geriatric assessment tools: a preliminary report from Indian population. JESP, 2007, Vol. 3, No. 2.

Appendix IV
Mini-Cog Assessment Instrument

The Mini-Cog assessment instrument comprises of two tests: 3-Item recall test and Clock Draw Test (CDT). It is less time consuming, needs no special equipment and useful even for poorly educated people.
Administration:

Step – 1: Patient is asked to listen carefully to 3 unrelated words and then to repeat them.

Step – 2: Patient is asked to draw a clock face either on a blank sheet of paper or on the clock circle already drawn on the page.
Patient is then asked to draw the hands of a clock to show the designated time. For completion of this task patient is given as much time as needed.

Step – 3: Patient is asked to repeat the 3 previously presented words.

Directions: Score 1 point for each recalled word after the CDT distractor.

Dementia is unlikely, if patient can remember all 3 items and draw the correct clock with the hands displaying the designated time.

Appendix V
Geriatric Depression Scale (GDS)

Question	*Answer*
1. Are you basically satisfied with your life?	Yes/**No**
2. Have you dropped many of your interests and activities?	**Yes**/No
3. Do you feel that your life is empty?	**Yes**/No
4. Do you often get bored?	**Yes**/No
5. Are you in good spirit most of the time?	Yes/**No**
6. Are you afraid that something bad is going to happen to you?	**Yes**/No
7. Do you feel happy most of the time?	Yes/**No**
8. Do you often feel helpless?	**Yes**/No
9. Do you prefer to stay at home rather than going out and doing new things?	**Yes**/No
10. Do you feel that you have more problems with memory than most?	**Yes**/No
11. Do you think it is wonderful to be alive now?	Yes/**No**
12. Do you feel pretty worthless the way you are now?	**Yes**/No
13. Do you feel of energy?	Yes/**No**
14. Do you feel that your situation is hopeless?	**Yes**/No
15. Do you think that most people are better off than you are?	**Yes**/No

Directions: Score 1 point for each bolded answer. A score of 5 or more is indicates depression.

Source: Sheikh JI, Yesavage JA: Geriatric Depression Scale: recent evidence and development of a shorter version. Clin Gerontol, 1986, 5:165-172.
Feher EP, Larrabee GJ, Crook TH 3rd: Factors attenuating the validity of the Geriatric Depression Scale in a dementia population. J Am Geratr Soc, 1992, 40: 906-909.
http://www.stanford.edu/~ yesavage/GDS.html

Appendix VI
Physical Therapy Evaluation Performa for Geriatric Patients

Subjective information:

Name:
Age/sex:
Occupation:
Address:
Phone:
e-mail:
Education:
Marital status:
Present occupational status:
Family status:
Financial dependence:
Smoking habit:
Alcohol addiction:
Any other addiction:
Social interactions:
Living alone or with others:
Hobbies:
Family friends:
Community involvement:
Chief Complaints:
History of present illness:
History of past illness:
Family history:
Drug history:

- Prescribed medications
- Non-prescribed medications
- Drug allergy
- Able to take medications by himself or herself

Physical examination:

- Height
- Weight
- Blood pressure in lying———— and in standing————————

- Pulse
- Edema
- Skin integrity, pallor
- Range of motion
- Muscle strength
- Sensory status
- Coordination
- Vision
- Hearing
- Oral cavity: No of teeth———, loose teeth————, caries————

Functional status:

- Basic self-care and personal hygiene activities of daily living (ADLs) (Appendix-I)
- More complex activities essential to live in community (IADLs) (Appendix-II)
- Balance (Appendix-III)
- Gait (Appendix-III)

Nutritional status:

- Number of meals taken daily
- Protein intake
  Dairy products per day:
  Legumes per week/day:
  Eggs per week/day:
  Meat, fish or poultry per week/day:
- Consumption pattern of fruits or vegetables per day
- Fluid intake
- Weight changes
- Has food intake declined over the past 3 months?
- Reasons for reduced intake
  i. Any loss of appetite
  ii. Reduced taste/smell
  iii. Any chewing, swallowing or problems in digestion
  iv. Any other reason (e.g. dentures, urinary, incontinence)
- Who prepares the food?
- Mode of feeding
  Unable to eat without assistance:
  Self-fed with some difficulty:
  Self-fed without any problem:
- In comparison with other people of the same age, how do they consider their health status?
  Not as good:
  Do not know:
  As good:
  Better:

Mental status: Appendix IV and V
Investigations:

Appendix VII
Dynamic Gait Index

Gait level surface

Instructions: walk at your normal pace from here to the next mark (20')

Response	*Scoring*
Normal: walks 20', no assistive device, good speed, no evidence for imbalance, normal gait pattern	3
Mild impairment: walks 20', uses an assistive device, slower speed, mild gait deviations	2
Moderate impairment: walks 20', slow speed, abnormal gait pattern, evidence for imbalance	1
Severe impairment: can not walk 20' without assistance severe gait deviation or imbalance	0

Change in gait speed

Instructions: Begin walking at your normal pace for 5', when told "go," walk as fast as you can for 5'. When told "slow," walk as slowly as you can for 5'.

Response	*Scoring*
Normal: able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speed between normal, fast and slow speeds	3
Mild impairment: is able to change speed but demonstrates mild gait deviations or not gait deviations but unable to achieve a significant change in walking speed or uses an assistive device	2
Moderate impairment: makes only minor adjustments to walking speed or accomplishes a change in speed with significant gait deviations.	1
Severe impairment: can not change speeds or loses balance and has to reach for wall or be caught	0

Gait with horizontal head turns

Instructions: Begin walking at your normal pace. When told “look right”, keep walking straight, but turn your head to the right, when told “look left”, then turn your head to the left, while still walking straight and when told “look straight”, then keep walking straight, but return your head to the center.

Response	*Scoring*
Normal: performs head turns smoothly without loss of balance or gait deviation.	3
Mild impairment: performs head turns smoothly but demonstrates mild gait deviations or uses an assistive device.	2
Moderate impairment: performs head turns with moderate change in speed.	1
Severe impairment: can not perform the task or loses Balance, stops, reaches for wall.	0

Gait with vertical head turns

Instructions: Begin walking at your normal pace. When told “look up”, keep walking straight, but tip your head up, when told “look down”, then tip your head down, while still walking straight and when told “look straight”, then keep walking straight, but return your head to the center.

Response	*Scoring*
Normal: performs head turns smoothly without loss of balance or gait deviation.	3
Mild impairment: performs head turns smoothly but demonstrates mild gait deviations or uses an assistive device.	2
Moderate impairment: performs head turns with moderate change in speed.	1
Severe impairment: can not perform the task or loses Balance, stops, reaches for wall.	0

Gait and pivot turn

Instructions: Begin walking at your normal pace. When told “turn and stop,” turn as fast as you can to face the opposite direction and then stop.

Response	*Scoring*
Normal: pivot turns safely within 3 seconds and stops quickly with no loss of balance.	3

Mild impairment: pivot turns safely in > 3 seconds and stops quickly with no loss of balance.	2
Moderate impairment: turns slowly, requires verbal cueing and several small steps to catch balance following turn and stop.	1
Severe impairment: can not turn safely, requires assistance to turn and stop.	0

Step over obstacle

Instructions: Begin walking at your normal pace. When you come to the shoebox, step over it and keep walking.

Response	*Scoring*
Normal: able to step over the box without changing walking speed or with no loss of balance.	3
Mild impairment: able to step over box but must slow down and adjust steps to clear box safely.	2
Moderate impairment: able to step over box but must stop, then step over. May require verbal cueing.	1
Severe impairment: can not perform task without assistance	0

Step around obstacles

Instructions: Begin walking at your normal pace. When you come to the first cone (about 6' away), walk around the right side of it and when you come to the second cone, (6' past first cone), walk around it to the left.

Response	*Scoring*
Normal: able to walk around the cones safely without changing walking speed or with no loss of balance.	3
Mild impairment: able to walk around the cones but must slow down and adjust steps to clear cones.	2
Moderate impairment: able to clear cones but significantly slow to complete the task. May require verbal cueing.	1
Severe impairment: can not perform task without assistance	0

Steps

Instructions: walk up the top of the stairs, turn around and then walk down the stairs.

Response	*Scoring*
Normal: alternating feet, no use of railing	3
Mild impairment: alternating feet, must use the railing	2
Moderate impairment: two feet to a stair, must use the railing	1
Severe impairment: can not perform task safely	0

Total score: ——/ 24

Directions: < 19/24 = predictive of falls in elderly
> 22/24 = safe ambulators

Source: Shumway-Cook A, Woollacott M: Motor Control Theory and Applications. Williams and Wilkins Baltimore, 1995, 323-324.

Appendix VIII
Wisconsin Gait Scale (WGS)

Submeasure	*Finding*	*Points*
Use of hand gait aid	• No gait aid	1
	• Minimal gait aid use	2
	• Minimal gait aid use wide base	3
	• Marked use	4
	• Marked use wide base	5
Stance time on impaired side	• Equal (time spent on affected side same as time spent on unaffected side during single leg stance)	1
	• Unequal	2
	• Very brief	3
Step length of unaffected side	• Step through (heel of unaffected foot clearly advances beyond the toe of the affected foot)	1
	• Foot does not clear	2
	• Step to (unaffected foot placed behind of up to affected foot but not beyond)	3
Weight shift to the affected side (with or without aid)	• Full shift head and trunk shift laterally over the affected foot gait during the single stance	1
	• Decreased shift	2
	• Very limited shift	3
Stance width	• Normal (up to 1 shoe width between feet)	1
	• Moderate (up to 2 shoe widths)	2
	• Wide (more than 2 shoe widths)	3
Guardedness	• None (good forward movement with no hesitance noted)	1
	• Slight	2
	• Marked hesitation	3
Hip extension of affected side	• Equal extension (hips equally extend during push off; maintains erect posture during toe off)	1
	• Slight flexion	2
	• Marked extension	3
External rotation during initial swing	• Same as unimpaired leg	1
	• Increased rotation	2
	• Marked	3

Submeasure	*Finding*	*Points*
Circumduction at mid swing	• None (affected foot adducts no more than unaffected foot during swing)	1
	• Moderate	2
	• Marked	3
Hip hiking at mid swing	• None (Pelvis slight dips during swing)	1
	• Elevation	2
	• Vaults	3
Knee flexion from toe off to mid swing	• Normal (affected knee flexes equally to unaffected side)	1
	• Some	2
	• Minimal	3
	• None	4
Toe clearance	• Normal (Toe clears floor throughout swing)	1
	• Slight drag	2
	• Marked	3
Pelvic rotation at terminal swing	• Forward (pelvis rotated forward to prepare for heel strike)	1
	• Neutral	2
	• Retracted	3
Initial foot contact	• Heel strike (heel makes the initial contact with the floor)	1
	• Foot flat	2
	• No contact of heel	3

Source: Rodriquez A A, Black P O, Kile K A, Sherman J, Stellberg B, Mc Cormick J, Roszkowski J, Swiggum: Gait training efficacy using a home - based practice model in chronic hemiplegia. Arch. Phy. Med. Rehabil, 1996, 77: 801 - 805.

Turani N, Kemiksizoglu A, Karatas M, Ozker R: Assessment of hemiplegic gait using the Wisconsin Gait Scale. Scandinavian Journal of Caring Sciences, 2004, 18: 103 - 108.

Appendix IX
Parkinson's Disease Evaluation Form

Bradykinesia of hands

0 No involvement
1 Detectable slowing of supination/pronation rate evidenced by beginning difficulty in handling tools; buttoning clothes; and with handwriting
2 Moderate slowing of supination/pronation rate, one or both sides, evidenced by moderate impairment of hand function. Handwriting is greatly impaired, micrographia
3 Severe slowing of supination/pronation rate. Unable to write or button clothes. Marked difficulty in handling utensils

Rigidity

0 Undetectable
1 Detectable rigidity in neck and shoulders. Activation phenomenon is present. One or both arms show mild, negative, resting rigidity
2 Moderate rigidity in neck and shoulders. Resting rigidity is positive when patient not on meds
3 Severe rigidity in neck and shoulders. Resting rigidity can not be reversed by meds

Posture

0 Normal posture. Head flexed forward less than 4 inches
1 Beginning poker spine. Head flexed forward up to 5 inches
2 Beginning arm flexion. Head flexed forward up to 6 inches. One or both arms flexed but still below waist
3 Onset of Simian posture. Head flexed forward more than 6 inches. Sharp flexion of hand, beginning interphalangeal extension. Beginning flexion of knees

Upper Extremity Swing

0 Swings both arms well
1 One arm decreased in amount of swing
2 One arm falls to swing
3 Both arms fall to swing

Gait

0 Step length is between 18-30 inches. Turns effortlessly
1 Step length shortened to 12-18 inches. Foot/floor contact abnormalities in one side. Turns around slowly and takes several steps
2 Step length 6-12 inches. Foot/floor contact abnormalities on both sides.
3 Onset of shuffling gait. Occasional stuttering gait with feet sticking to floor. Walks on toes. Turns very slowly

Tremor

0 No tremor
1 Less than 1 inch amplitude tremor observed in limbs or head at rest or in either hand while walking
2 Maximum tremor envelope fails to exceed 4 inches. Tremor is severe but not constant. Patient still has some control of hands
3 Tremor envelope exceeds 4 inches. Tremor is severe and constant. Writing and feeding are impossible

Face

0 Normal. Full animation. No stare
1 Detectable immobility. Mouth remains closed. Beginning features of anxiety or depression
2 Moderate immobility. Emotion shows at markedly increased threshold. Lips parted some of the time. Moderate features of anxiety or depression. Drooling may occur
3 Frozen face. Mouth slightly open. Severe drooling may be present

Speech

0 Clear, loud, resonant, easily understood
1 Beginning of hoarseness with loss of inflection and resonance. Good volume. Still easily understood
2 Moderate hoarseness and weakness. Constant monotone, unvaried pitch, early dysarthria, hesitancy, stuttering, difficult to understand
3 Marked hoarseness and weakness. Very difficult to hear and understand

Self-care

0 No impairment
1 Still provides full self-care but rate of dressing definitely slowed. Able to live alone and still employable
2 Requires help in certain critical areas such as turning in bed, rising from chairs etc. Very slow in performing most activities but manages by taking time
3 Continuously disabled. Unable to dress, feed self or walk alone

Directions: Overall disability = sum of the scores from all categories
Early stage of disability: 1-9
Moderate disability: 10-18
Severe disability: 19-27

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